BECKHOFF New Automation Technology

Documentation | EN

IL230x-B110

Fieldbus Box for EtherCAT

2017-05-29 | Version: 1.0.3

Table of contents

1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Description of instructions

In this documentation the following instructions are used.
These instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
1.0.3	• Translation of chapter *Diagnostic LEDs for EtherCAT* corrected
1.0.2	• System overview updated • Description of CoE Interface updated
1.0.1	• EtherCAT connection updated
1.0	• First release

1.4 Bus Coupler as a general term

Parts of this manual give general information about Ethernet implementation in Beckhoff products.
Thus in the following often the term *Bus Coupler* is used, that describes not only the IP20 products, but also means the IP67 modules.

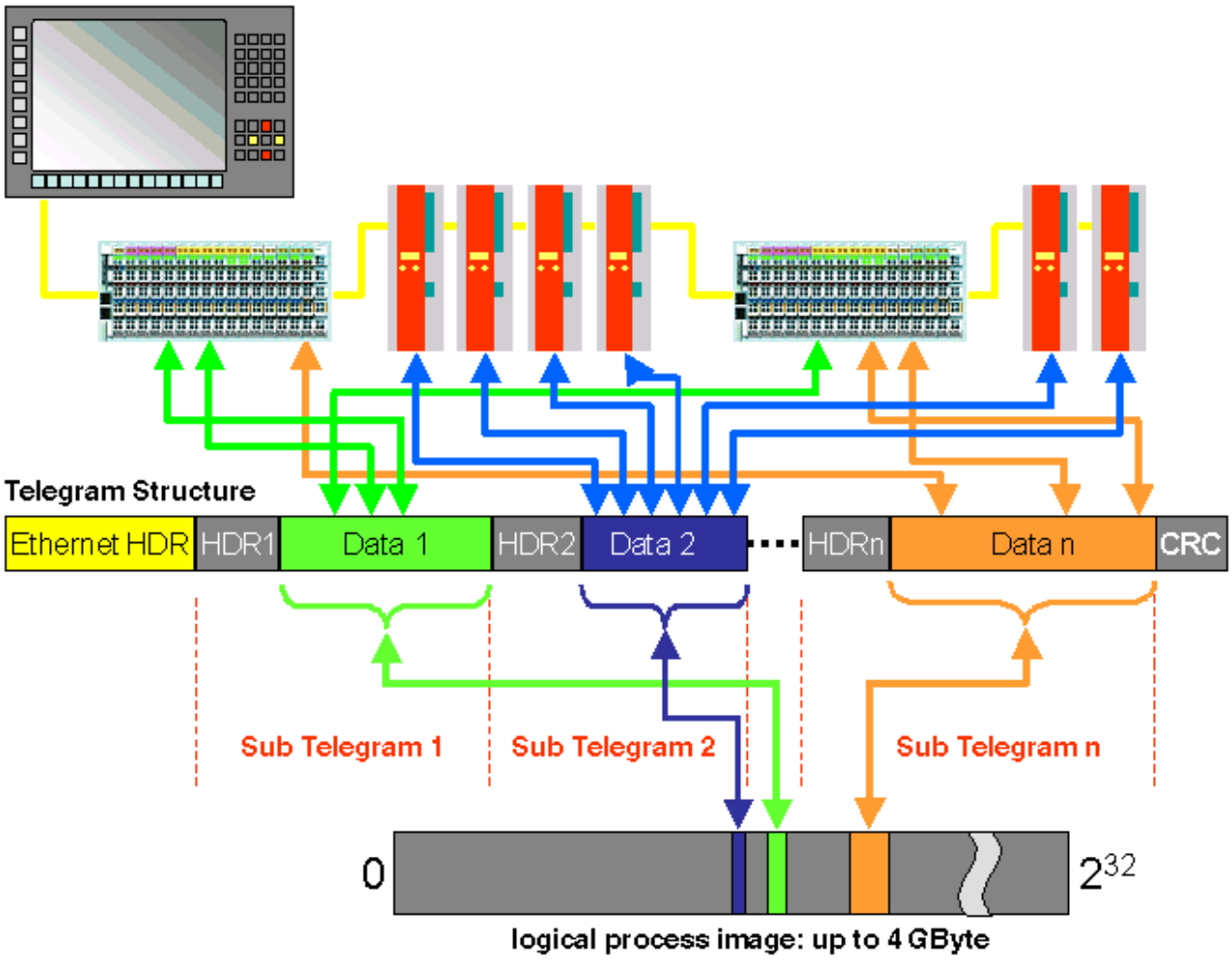
2 Basics

2.1 System Properties

Protocol

The EtherCAT protocol is optimized for process data and is transported directly within the Ethernet frame thanks to a special Ether-type. It may consist of several sub-telegrams, each serving a particular memory area of the logical process images that can be up to 4 gigabytes in size. The data sequence is independent of the physical order of the Ethernet terminals in the network; addressing can be in any order. Broadcast, Multicast and communication between slaves are possible. Transfer directly in the Ethernet frame is used in cases where EtherCAT components are operated in the same subnet as the control computer.

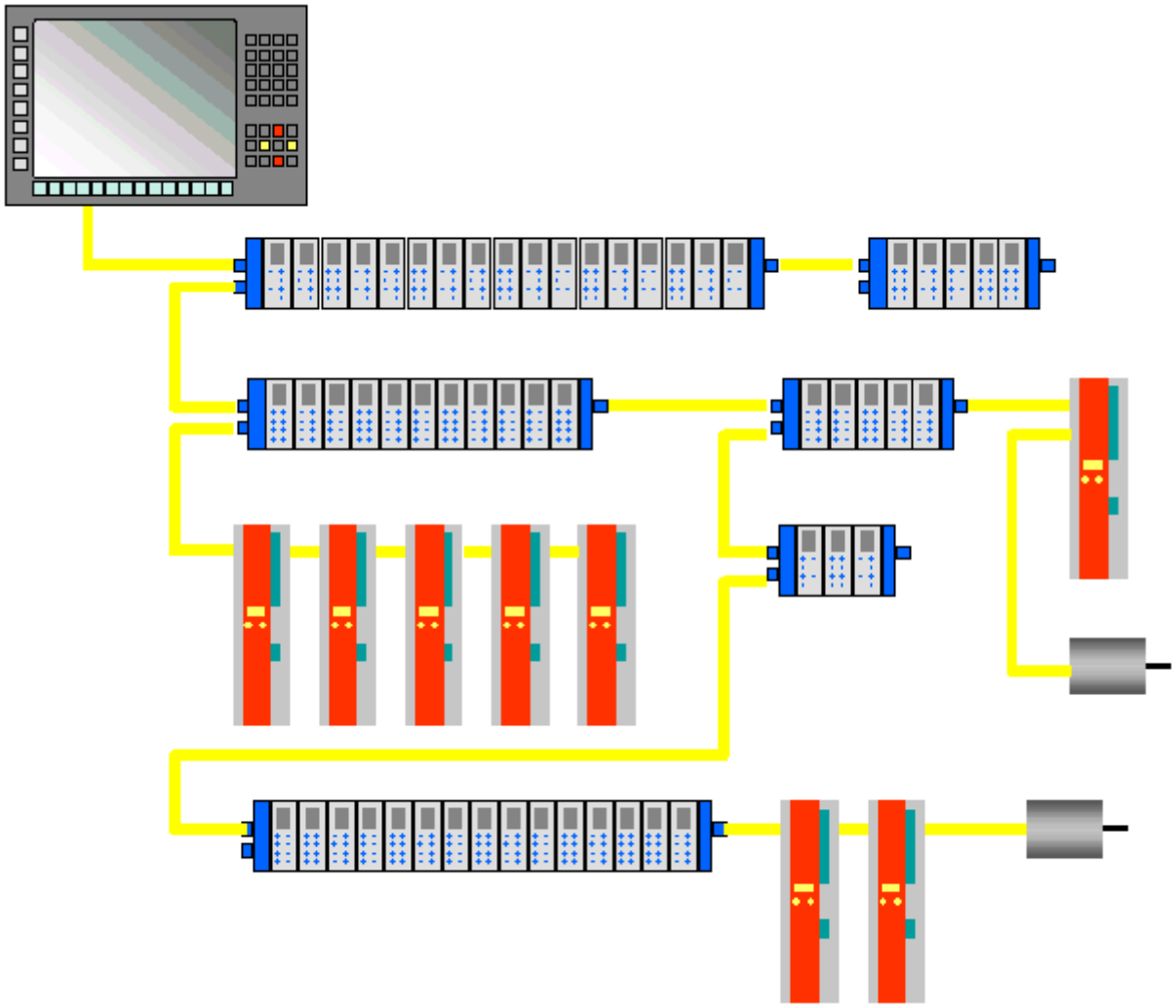
However, EtherCAT applications are not limited to a subnet: EtherCAT UDP packs the EtherCAT protocol into UDP/IP datagrams. This enables any control with Ethernet protocol stack to address EtherCAT systems. Even communication across routers into other subnets is possible. In this variant, system performance obviously depends on the real-time characteristics of the control and its Ethernet protocol implementation. The response times of the EtherCAT network itself are hardly restricted at all: the UDP datagram only has to be unpacked in the first station.



Protocol structure: The process image allocation is freely configurable. Data are copied directly in the I/O terminal to the desired location within the process image: no additional mapping is required. The available logical address space is with very large (4 GB).

Topology

Line, tree or star: EtherCAT supports almost any topology. The bus or line structure known from the fieldbusses thus also becomes available for Ethernet. Particularly useful for system wiring is the combination of line and branches or stubs. The required interfaces exist on the couplers; no additional switches are required. Naturally, the classic switch-based Ethernet star topology can also be used.



Maximum wiring flexibility:
with or without switch, line or tree topologies, can be freely selected and combined. The complete bandwidth of the Ethernet network - such as different optical fibers and copper cables - can be used in combination with switches or media converters.

Distributed Clocks

Accurate synchronization is particularly important in cases where spatially distributed processes require simultaneous actions. This may be the case, for example, in applications where several servo axes carry out coordinated movements simultaneously.

The most powerful approach for synchronization is the accurate alignment of distributed clocks, as described in the new IEEE 1588 standard. In contrast to fully synchronous communication, where synchronization quality suffers immediately in the event of a communication fault, distributed aligned clocks have a high degree of tolerance vis-à-vis possible fault-related delays within the communication system.

With EtherCAT, the data exchange is fully based on a pure hardware machine. Since the communication utilizes a logical (and thanks to full-duplex Fast Ethernet also physical) ring structure, the mother clock can determine the run-time offset to the individual daughter clocks simply and accurately - and vice versa. The distributed clocks are adjusted based on this value, which means that a very precise network-wide timebase with a jitter of significantly less then 1 microsecond is available.

However, high-resolution distributed clocks are not only used for synchronization, but can also provide accurate information about the local timing of the data acquisition. For example, controls frequently calculate velocities from sequentially measured positions. Particularly with very short sampling times, even a small temporal jitter in the displacement measurement leads to large step changes in velocity. With EtherCAT new, extended data types are introduced as a logical extension (time stamp and oversampling data type). The local time is linked to the measured value with a resolution of up to 10 ns, which is made possible by the large bandwidth offered by Ethernet. The accuracy of a velocity calculation then no longer depends on the jitter of the communication system. It is orders of magnitude better than that of measuring techniques based on jitter-free communication.

Performance

EtherCAT reaches new dimensions in network performance. Protocol processing is purely hardware-based through an FMMU chip in the terminal and DMA access to the network card of the master. It is thus independent of protocol stack run-times, CPU performance and software implementation. The update time for 1000 I/Os is only 30 µs - including terminal cycle time. Up to 1486 bytes of process data can be exchanged with a single Ethernet frame - this is equivalent to almost 12000 digital inputs and outputs. The transfer of this data quantity only takes 300 µs.

The communication with 100 servo axes only takes 100 µs. During this time, all axes are provided with set values and control data and report their actual position and status. Distributed clocks enable the axes to be synchronised with a deviation of significantly less than 1 microsecond.

The extremely high performance of the EtherCAT technology enables control concepts that could not be realized with classic fieldbus systems. For example, the Ethernet system can now not only deal with velocity control, but also with the current control of distributed drives. The tremendous bandwidth enables status information to be transferred with each data item. With EtherCAT, a communication technology is available that matches the superior computing capacity of modern Industrial PCs. The bus system is no longer the bottleneck of the control concept. Distributed I/Os are recorded faster than is possible with most local I/O interfaces. The EtherCAT technology principle is scalable and not bound to the baud rate of 100 MBaud – extension to GBit Ethernet is possible.

Diagnostics

Experience with fieldbus systems shows that availability and commissioning times crucially depend on the diagnostic capability. Only faults that are detected quickly and accurately and which can be precisely located can be corrected quickly. Therefore, special attention was paid to exemplary diagnostic features during the development of EtherCAT.

During commissioning, the actual configuration of the I/O terminals should be checked for consistency with the specified configuration. The topology should also match the saved configuration. Due to the built-in topology recognition down to the individual terminals, this verification can not only take place during system start-up, automatic reading in of the network is also possible (configuration upload).

Bit faults during the transfer are reliably detected through evaluation of the CRC checksum: The 32 bit CRC polynomial has a minimum hamming distance of 4. Apart from breaking point detection and localization, the protocol, physical transfer behavior and topology of the EtherCAT system enable individual quality monitoring of each individual transmission segment. The automatic evaluation of the associated error counters enables precise localization of critical network sections. Gradual or changing sources of error such as EMC influences, defective push-in connectors or cable damage are detected and located, even if they do not yet overstrain the self-healing capacity of the network.

Integration of standard Bus Terminals from Beckhoff

In addition to the new Bus Terminals with E-Bus connection (ELxxxx), all Bus Terminals from the familiar standard range with K-Bus connection (KLxxxx) can be connected via the BK1120 or BK1250 Bus Coupler. This ensures compatibility and continuity with the existing Beckhoff Bus Terminal systems. Existing investments are protected.

2.2 CoE Interface

Object directory

All EtherCAT slaves supporting the CoE interface have an object directory containing all parameter, diagnostic, process or other data that can be read or written via EtherCAT.

The object directory can be read via the SDO information service. It is included in the device description file. All EtherCAT slaves should support the SDO information service at least to such an extent that the compact object description of each object can be read (from index 0x1000). This object description contains the data type, the length, the access rights and information as to whether the object can be mapped in a PDO (and therefore can be used as process data).

Start-Up list

The Start-up list describes the interrelationship between EtherCAT state machine, process data mapping and device parameter settings during start-up of EtherCAT network.

Restoring the delivery state

Restoring the delivery state To restore the delivery state for backup objects in ELxxxx terminals, the CoE object "Restore default parameters", SubIndex 001 can be selected in the TwinCAT System Manager (Config mode) (see Fig. 1)

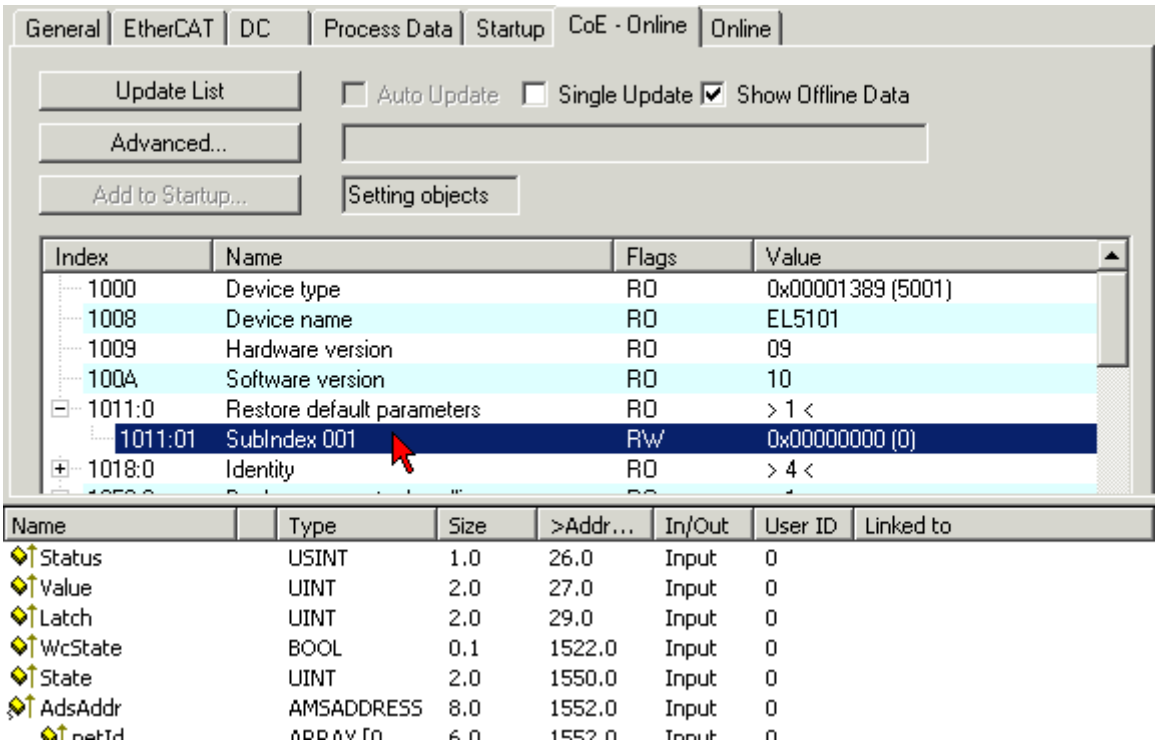


Fig. 1 Selecting the "Restore default parameters" PDO

Double-click on SubIndex 001 to enter the Set Value dialog. Enter the value **1684107116** in field "Dec" or the value **0x64616F6C** in field "Hex" and confirm with *OK* (Fig. 2).
All backup objects are reset to the delivery state.

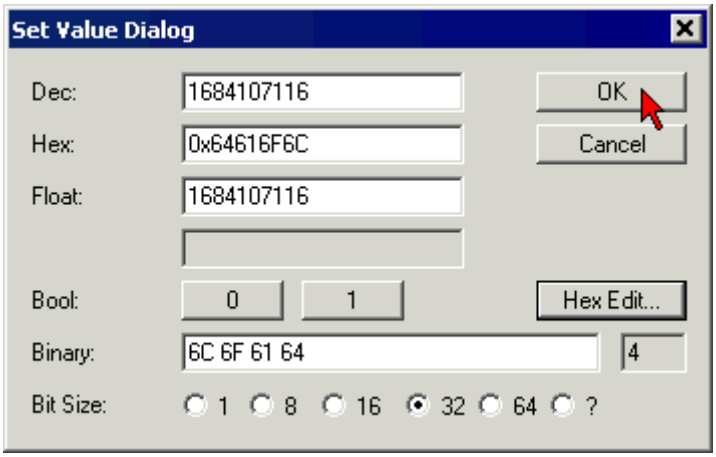


Fig. 2 Entering a restore value in the Set Value dialog

Alternative restore value

In some older terminals the backup objects can be switched with an alternative restore value: Decimal value: "1819238756" Hexadecimal value: "0x6C6F6164" An incorrect entry for the restore value has no effect.

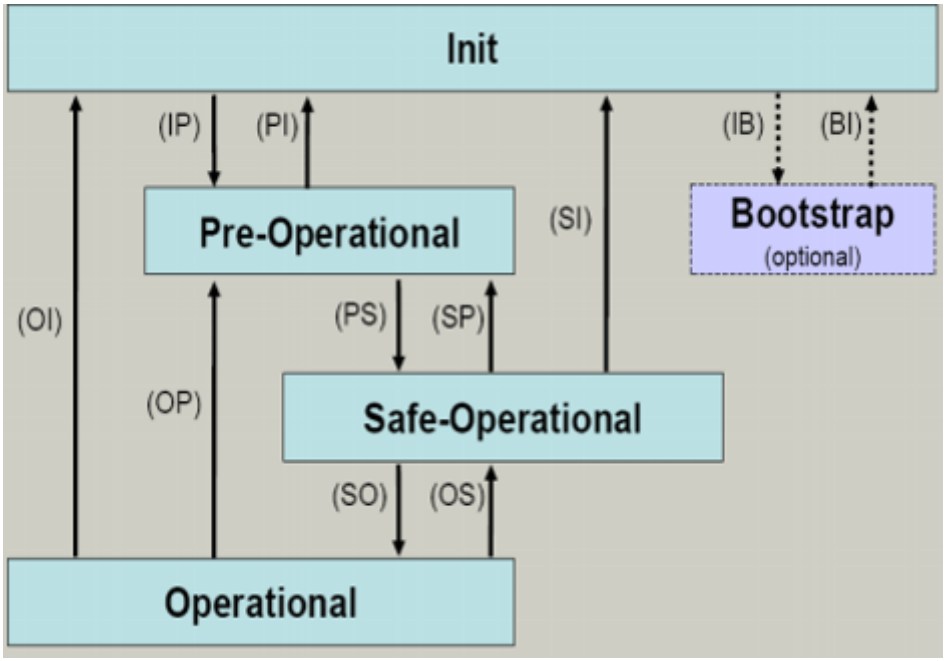
2.3 EtherCAT State Machine

The state of the EtherCAT slave is controlled via the EtherCAT State Machine (ESM). Depending upon the state, different functions are accessible or executable in the EtherCAT slave. Specific commands must be sent by the EtherCAT master to the device in each state, particularly during the bootup of the slave.

A distinction is made between the following states:

- Init
- Pre-Operational
- Safe-Operational and
- Operational
- Boot

The regular state of each EtherCAT slave after bootup is the OP state.



Init

After switch-on the EtherCAT slave in the *Init* state. No mailbox or process data communication is possible. The EtherCAT master initializes sync manager channels 0 and 1 for mailbox communication.

Pre-Operational (Pre-Op)

During the transition between *Init* and *Pre-Op* the EtherCAT slave checks whether the mailbox was initialized correctly.

In *Pre-Op* state mailbox communication is possible, but not process data communication. The EtherCAT master initializes the sync manager channels for process data (from sync manager channel 2), the FMMU channels and, if the slave supports configurable mapping, PDO mapping or the sync manager PDO assignment. In this state the settings for the process data transfer and perhaps terminal-specific parameters that may differ from the default settings are also transferred.

Safe-Operational (Safe-Op)

During transition between *Pre-Op* and *Safe-Op* the EtherCAT slave checks whether the sync manager channels for process data communication and, if required, the distributed clocks settings are correct. Before it acknowledges the change of state, the EtherCAT slave copies current input data into the associated DP-RAM areas of the EtherCAT slave controller (ECSC).

In *Safe-Op* state mailbox and process data communication is possible, although the slave keeps its outputs in a safe state, while the input data are updated cyclically.

Outputs in SAFEOP state

The default set watchdog monitoringremoved link: watchdog monitoring sets the outputs of the module in a safe state - depending on the settings in SAFEOP and OP - e.g. in OFF state. If this is prevented by deactivation of the watchdog monitoring in the module, the outputs can be switched or set also in the SAFEOP state.

Operational (Op)

Before the EtherCAT master switches the EtherCAT slave from *Safe-Op* to *Op* it must transfer valid output data.

In the *Op* state the slave copies the output data of the masters to its outputs. Process data and mailbox communication is possible.

Boot

In the *Boot* state the slave firmware can be updated. The *Boot* state can only be reached via the *Init* state.

In the *Boot* state mailbox communication via the *file access over EtherCAT* (FoE) protocol is possible, but no other mailbox communication and no process data communication.

3 Product overview

3.1 The Fieldbus Box System

Fieldbus box modules are robust fieldbus stations for a large number of different fieldbus systems. They offer a wide range of I/O functionality. All relevant industrial signals are supported. As well as digital and analog inputs and outputs including thermocouple and RTD inputs, there are also incremental encoder interfaces available for displacement and angle measurement as well as serial interfaces to solve a large number of communications tasks.

Three varieties of signal connection

The digital inputs and outputs can be connected with snap-on 8 mm diameter plugs, screw-in M8 connectors, or with screw-in M12 pendants. The M12 version is provided for analog signals.

All important signal types

Special input and output channels on the combination I/O modules can be used for either input or output. It is not necessary to configure them, since the fieldbus interface is available for every combination channel as well as for input and output data. The combination modules give the user all of the advantages of fine signal granularity.

The processor logic, the input circuitry and the power supply for the sensor are all fed from the control voltage. The load voltage for the outputs can be supplied separately. In those Fieldbus Boxes in which only inputs are available, the load power supply, UP, can optionally be connected in order to pass it on downstream.

The states of the Fieldbus Box, the fieldbus connection, the power supplies and of the signals are indicated by LEDs.

The label strips can be machine printed elsewhere, and then inserted.

Fieldbus Boxes can be combined for greater flexibility

In addition to the Compact Box, the Fieldbus Box series also includes extendable devices, namely the Coupler Box and the Extension Box, as well as intelligent devices, the PLC Boxes.

Compact Box

The Compact Box makes the I/O data from the connected digital and analog sensors and actuators available to the fieldbus.

Coupler Box

The Coupler Box also collects I/O data from the Extension Boxes via an interference-proof optical fiber connection (IP-Link). Up to 120 Extension Boxes can be connected to a Coupler Box. In this way a distributed IP67 I/O network is formed with only one fieldbus interface.

The Coupler Box is capable of automatically recognizing the extension modules connected to it during start-up, and maps the I/O data automatically into the fieldbus process image – a configuration is not necessary. The Coupler Box appears, from the fieldbus point of view, along with all of the networked Extension Boxes, as a single participating bus device with a corresponding number of I/O signals.

The Coupler Box corresponds to the Bus Coupler in the BECKHOFF Bus Terminal system. BECKHOFF fieldbus devices made to protection class IP 20 (Bus Terminals) and IP 67 (Fieldbus Box) can be combined without difficulty – the data is handled in the same way in either case.

IP-Link

The IP-Link is an optical fiber connection with a transmission rate of 2 MBits/s which is capable of transmitting 1000 items of binary I/O data in approx. 1 ms, rapidly and securely. Smaller configurations are correspondingly faster. Because of the high usable data rate, the coupling via IP-Link does not reduce the performance of the fieldbus at all.

Low-priced plug connectors made according to Protection Class IP 67 can be used for the rapid and simple preparation of the IP-Link cable, in situ. The connection does not require special tools, and can be performed quickly and simply. The IP-Link cables can also be obtained with prepared plugs if required.

The separate supply of the output voltage allows output groups to be switched off individually. Differing potentials can also be created within an extension ring without difficulty, since the IP-Link naturally has optimum electrical isolation.

Extension box

Like the Compact Boxes, the Extension Boxes cover the full spectrum of I/O signals, and may be up to 15 m apart. They are remarkably small in size, and lead to particularly economical I/O solutions with high levels of protection. Here again, the digital inputs and outputs may optionally be connected via snap-on 8 mm connectors, or via screw-in connectors (M8 and M12). Analog signal types are provided with the M12 version. The snap-on connectors lock in place positively, forming a shake-proof connection, while the screw-in connectors offer the advantage of high resistance to being pulled out.

PLC Box

The PLC Box is an intelligent Fieldbus Box with PLC functionality for distributed pre-processing of the I/O signals. This allows parts of the application to be farmed out from the central controller. This reduces the load on the CPU and the fieldbus. Distributed counting, controlling and switching are typical applications for the PLC Box. The reaction times are independent of the bus communication and of the higher-level controller.

In the event of a bus or controller failure, maintenance of function (e.g. bringing the process to a safe state in an orderly manner) is possible.

Programming is carried out with TwinCAT in accordance with IEC 61131-3. Five different programming languages are available:

- Instruction List (IL)
- Function Block Diagram (FBD)
- Ladder Diagram (LD)
- Sequential Function Chart (SFC)
- Structured Text (ST)

The program download occurs either via the fieldbus or via the programming interface.

Extensive debugging functions (breakpoint, single step, monitoring, etc) are also available. The PLC Box contains a powerful 16 bit controller, 32/96 kByte program memory and 32/64 kByte data memory. A further 512 bytes of non-volatile memory are available for remanent flags.

PLC Box with IP-Link

The programmable PLC Box with IP-Link provides almost unlimited I/O possibilities. Up to 120 extension modules, with more than 2000 I/Os, can be directly addressed from the PLC program. The PLC Box is thus also suitable for use as a small, autonomous controller for the operation of parts of equipment or small machines.

3.2 Fieldbus Box - Naming conventions

The identifications of the Fieldbus Box modules are to be understood as follows:
IXxxxy-zyyy

IX describes the design:

"IP" stands for the Compact Box design [▶ 18]
"IL" stands for the Coupler Box design (with IP-Link) [▶ 18]
"IE" stands for the Extension Box design [▶ 18]

xxxy describes the I/O connection:

xxx describes the I/O property:
"10x" - 8 x digital inputs
"15x" - counter module
"20x" - 8 x digital outputs
"25x" - PWM module
"23x" - 4 x digital inputs and 4 x digital outputs
"24x" - 8 x digital inputs and 8 x digital outputs
"3xx" - 4 x analog inputs
"4xx" - 4 x analog outputs
"5xx" - incremental encoder or SSI transducer
"6xx" - Gateway module for RS232, RS422, RS485, TTY

y represents the mechanical connection:
"0" stands for 8mm snap-on connection,
"1" stands for M8 bolted connection
"2" stands for M12 bolted connection and
"9" stands for M23 bolted connection

zyyy describes the programmability and the fieldbus system

z distinguishes whether the device is a slave or is a programmable slave:

"B" - not programmable
"C" - programmable (PLC Box)

"yyy" stands for the fieldbus system and the bus connection:
"110" - EtherCAT
"200" - Lightbus
"310" - PROFIBUS
"318" - PROFIBUS with integrated tee-connector
"400" - Interbus
"510" - CANopen
"518" - CANopen with integrated tee-connector
"520" - DeviceNet
"528" - DeviceNet with integrated tee-connector
"730" - Modbus
"800" - RS485
"810" - RS232
"900" - Ethernet TCP/IP with RJ45 for the bus connection
"901" - Ethernet TCP/IP with M12 for the bus connection
"903" - PROFINET
"905" - EtherNet/IP

Compact Box

Compact Box

The Compact Box modules offer a wide range of I/O functionality. All relevant industrial signals are supported. The digital inputs and outputs can be connected either with snap-on 8 mm diameter plugs, screw-in M8 connectors, or screw-in M12 connectors. The M12 version is made available for analog signals.

Depending on the module, the I/O section and the power supply section can differ.

Coupler Box

Coupler Box

There are three versions of the coupler box named IL230x-Bxxx. It differs from the compact box in that this module offers an interface to what are known as extension boxes. This interface is a subsidiary bus system based on the optical fiber what is known as IP Link. This powerful subsidiary bus system can handle up to 120 extension boxes at one coupler box.

Extension Box

Extension Box

Extension Modules, that are independent of the fieldbus and that can only be operated together with a coupler box via IP Link.

PLC Box

PLC Box

A PLC Box differ from the Coupler Box in that this module can be programmed in IEC 61131-3. This means that this slave is also capable of working autonomously, without a master, for instance for control or regulation tasks.

Also see about this

Fieldbus Box - Naming conventions [▶ 18]

3.3 Firmware and hardware issue status

The documentation refers to the hardware and software status that was valid at the time it was prepared. The properties are subject to continuous development and improvement. Modules having earlier production statuses cannot have the same properties as modules with the latest status. Existing properties, however, are always retained and are not changed, so that these modules can always be replaced by new ones. The number beginning with a *D* allows you to recognize the firmware and hardware status of a module.

Syntax:

D . ww yy x y z u

ww - calendar week
yy - year
x - bus board firmware status
y - bus board hardware status
z - I/O board firmware status
u - I/O board hardware status

Example:

D.22081501

- Calendar week 22
- in the year 2008
- bus board firmware status: 1
- bus board firmware hardware status: 5
- I/O board firmware status: 0 (no firmware is necessary for this board)
- I/O board hardware status: 1

3.4 Technical data

Technical data	IL230x-B110
Extension modules (IL....)	max. 32 (until firmware version B0) max. 78 (from firmware version B1)
Number of bytes, fieldbus	max. 512 bytes Input and max. 512 bytes output
Digital peripheral signals (IL....)	max. 624 inputs and max. 624 outputs
Analog peripheral signals (IL....)	max. 128 inputs and max. 128 outputs
Data transfer medium	4 x 2 twisted pair copper cable; category 5 (100 Mbaud)
Baud rate	100 Mbaud
Distance between modules	100 m
Configuration	KS2000 configuration software, TwinCAT System Manager or via EtherCAT (ADS)
Protocols	EtherCAT (Direct Mode)
Power supply	Control voltage: 24V_{DC} (-15%/+20%); load voltage: According to I/O type
Control voltage current consumption	According to I/O type + current consumption of sensors, max. 0.5 A
Load voltage current consumption	According to I/O type
Power supply connection	Feed: 1 x M8 plug, 4-pin Onward connection: 1 x M8 socket, 4-pin (except IP/IE204x)
Fieldbus connection	2 x M12 d-coded, socket
Electrical isolation	Channels/control voltage: no between the channels: no Control voltage/fieldbus: yes
Operating temperature	0°C... +55°C
Storage temperature	-25°C... +85°C
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	conforms to EN 61000-6-2 (EN 50082) / EN 61000-6-4 (EN 50081)
Protection class	IP 65/66/67 (conforms to EN 60529)
Installation position	any
Approvals	CE, UL E172151

Further documentation

Detailed technical data for all available I/O variants can be found under Signal variants, Installation, I/O module configuration on Products & Solutions CD from Beckhoff or on the Internet (http://www.beckhoff.com) under Download/Fieldbus Box.

4 Mounting and wiring

4.1 Dimensions

All dimensions are given in millimeters.

General

Technical data	Fieldbus Box
Material	PA6 (polyamide), casting compound: polyurethane
Assembly	2 x fixing holes for M3
Metal parts	Brass, nickel-plated
Contacts	CuZn, gold-plated
Vibration / shock resistance	according to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	according to EN 61000-6-2 (EN 50082) / EN 61000-6-4 (EN 50081)
Permissible ambient temperature during operation	0 ... 55°C
Permissible ambient temperature during storage	-25 ... + 85°C
Installation position	any
Type of protection	IP65/66/67 when screwed together
Approvals	CE, UL E172151

IPxxxx-Bxx8, IL230x-Bxx8, IL230x-B110, IXxxxx-B400, IXxxxx-B90x, IXxxxx-C900

Technical data	Compact and Coupler Box with integrated tee connector
Dimensions (H x W x D)	ca. 210 x 30 x 26,5 mm (height to upper edge of fieldbus socket: 30 mm)
Weight	ca. 260 g - 290 g, depending on module type

IPxxxx-Bxx0, IL230x-Bxx0, IL230x-Cxx0

Technical data	Compact and Coupler Box
Dimensions (H x W x D)	Approx. 175 x 30 x 26.5 mm (height to upper edge of fieldbus socket: 30 mm, with T- connector ZS1031-2600 height approx. 65 mm)
Weight	Approx. 250 g - 280 g, depending on module type

IExxxx

Technical data	Extension box
Dimensions (H x W x D)	Approx. 126 x 30 x 26.5 mm
Weight	Approx. 120 g - 200 g, depending on module type

4.2 EtherCAT connection

The EtherCAT connection is established via two d-coded M12 sockets (one for the EtherCAT input, one for the output).

The cable length between two EtherCAT devices must not exceed 100 m.

Cables and connectors

For connecting EtherCAT devices only Ethernet cables that meet the requirements of at least category 5 (CAt5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.

The following cables and connectors are suitable for application in EtherCAT systems:

Name	Comment
ZB9010	EtherCAT cable, fixed installation, CAT 5e, 4-core
ZB9020	EtherCAT cable, suitable for drag chain applications CAT 5e, 4-core
ZS1090-0004	M12 connector, 4-pin, IP67, field-configurable
ZK1090-6161-0005	EtherCAT cable, ready-made, M12 connector - M12 connector, 0.5 m length
ZK1090-6161-0010	EtherCAT cable, ready-made, M12 connector - M12 connector, 1.0 m length
ZK1090-6161-0020	EtherCAT cable, ready-made, M12 connector - M12 connector, 2.0 m length
ZK1090-6161-0025	EtherCAT cable, ready-made, M12 connector - M12 connector, 2.5 m length
ZK1090-6161-0050	EtherCAT cable, ready-made, M12 connector - M12 connector, 5.0 m length
ZK1090-6161-0100	EtherCAT cable, ready-made, M12 connector - M12 connector, 10 m length
ZK1090-6292-0005	EtherCAT cable, female M12 connector - RJ45, 0.5 m length
ZK1090-6292-0020	EtherCAT cable, female M12 connector - RJ45, 2.0 m length

Data sheets

There are different standards for assignment and colors at plugs and cables for Ethernet/EtherCAT. Please take assignment and colors of Beckhoff cables from the according data sheets.

Pin assignment of the M12 plug (d-coded)

PIN	Signal	Description
1	Tx +	Transmit Data+
2	Rx +	Receive Data+
3	Tx-	Transmit Data-
4	Rx-	Receive Data-

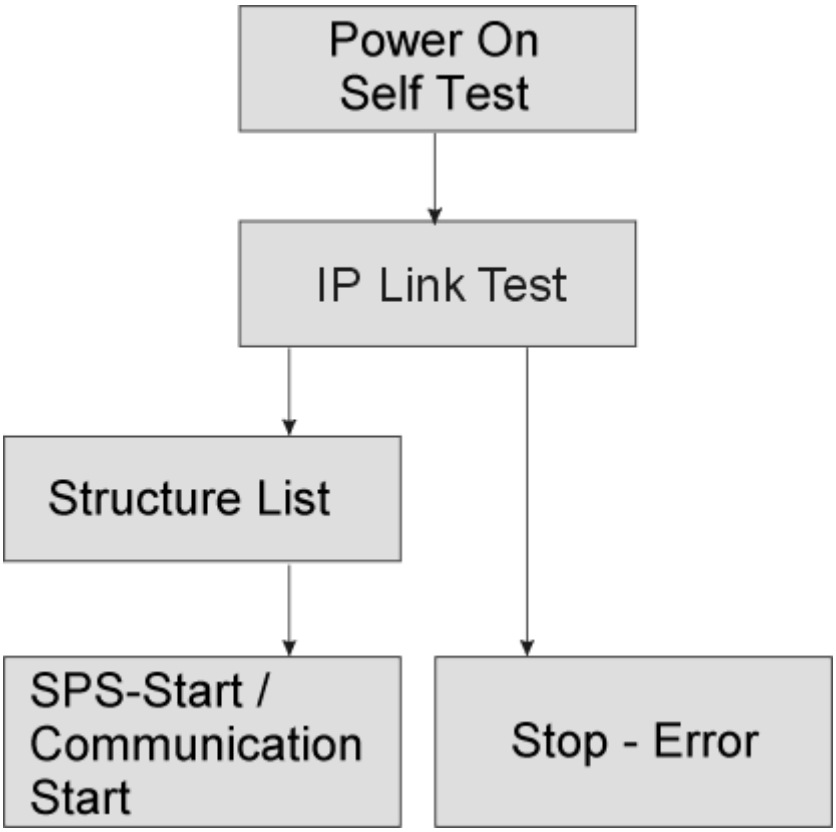
Pin assignment of the RJ45 plug

PIN	Signal	Description
1	TD +	Transmit Data+
2	TD -	Transmit Data-
3	RD +	Receive Data+
4	-	reserved
5	-	reserved
6	RD -	Receive Data-
7	-	reserved
8	-	reserved

5 Parameterizning and commissioning

5.1 Start-up behavior of the Fieldbus Box

After power up, the Fieldbus Box checks its state, configures the IP-Link (if present) and refers to the extension modules to create a structure list. If the Fieldbus Box contains a decentralized controller (IL230x-C310) the local PLC is started once the structure list has successfully been created.
The I/O LEDs illuminate and flash as the module starts up. If there are no errors, the I/O LEDs should stop flashing within about 2-3 seconds. If there is an error, then the LED that flashes will depend on the type of that error (see Diagnostic LEDs).



6 Configuration

6.1 TwinCAT System Manager

6.1.1 Configuration overview

IL230x-B110 (IL2300-B110, IL2301-B110, IL2302-B110)

IL230x-B110 (IL2300-B110, IL2301-B110, IL2302-B110)

In TwinCAT System Manager Config mode enter the IL230x-B110 as an EtherCAT (Direct Mode) device under Devices (Fig. 1). Any Fieldbus Box modules already connected to the network can also be read. All boxes with extensions and configurations are uploaded automatically. You can then adapt these to meet your requirements. FreeRun status must be set in TwinCAT.

Note regarding the screenshots: IP-Link values are displayed as K-Bus values in TwinCAT.

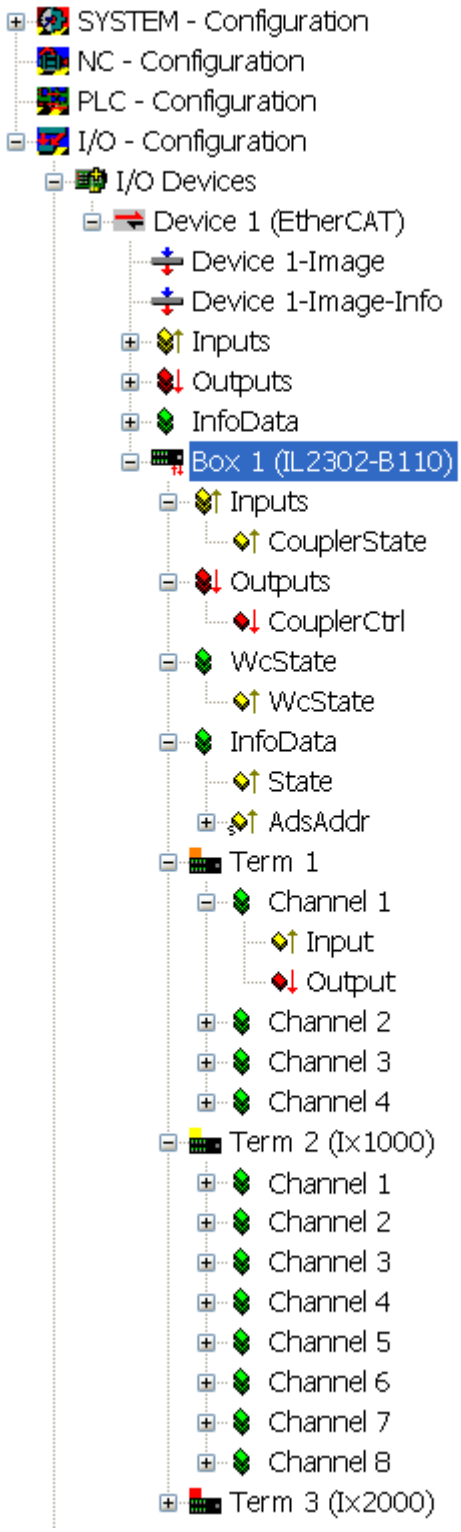


Fig. 1: Fbb_B110_TCAT_Sysman1

Fig. 1 TwinCAT tree IL2302-B110

Inputs

Inputs

CouplerState, "Online" tab

Display of general Fieldbus Box errors.

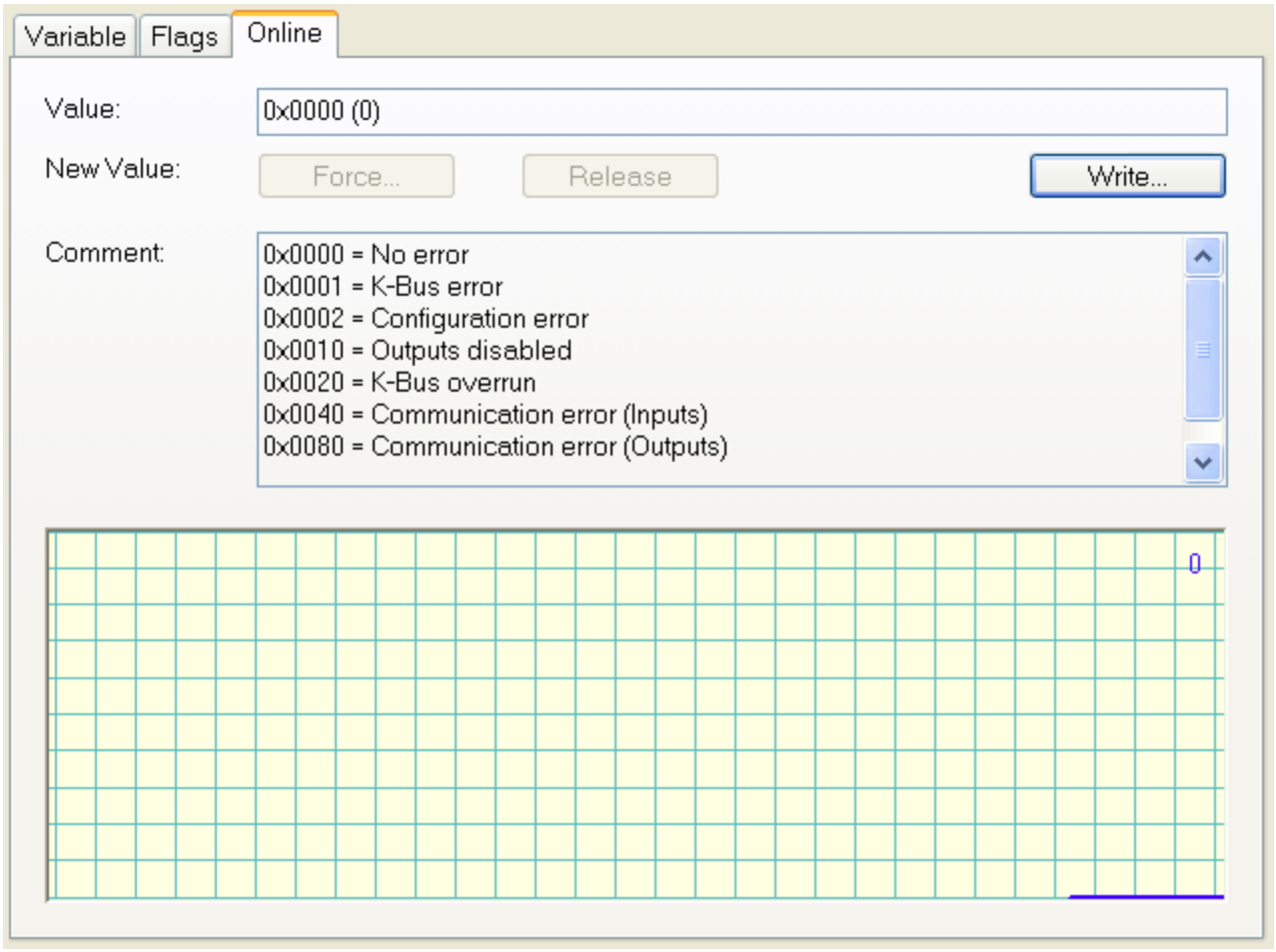


Fig. 3 CouplerState, "Online" tab

Outputs

Outputs

CouplerCtrl, "Online" tab

Display of IP-Link/K-Bus errors or deactivation of outputs.

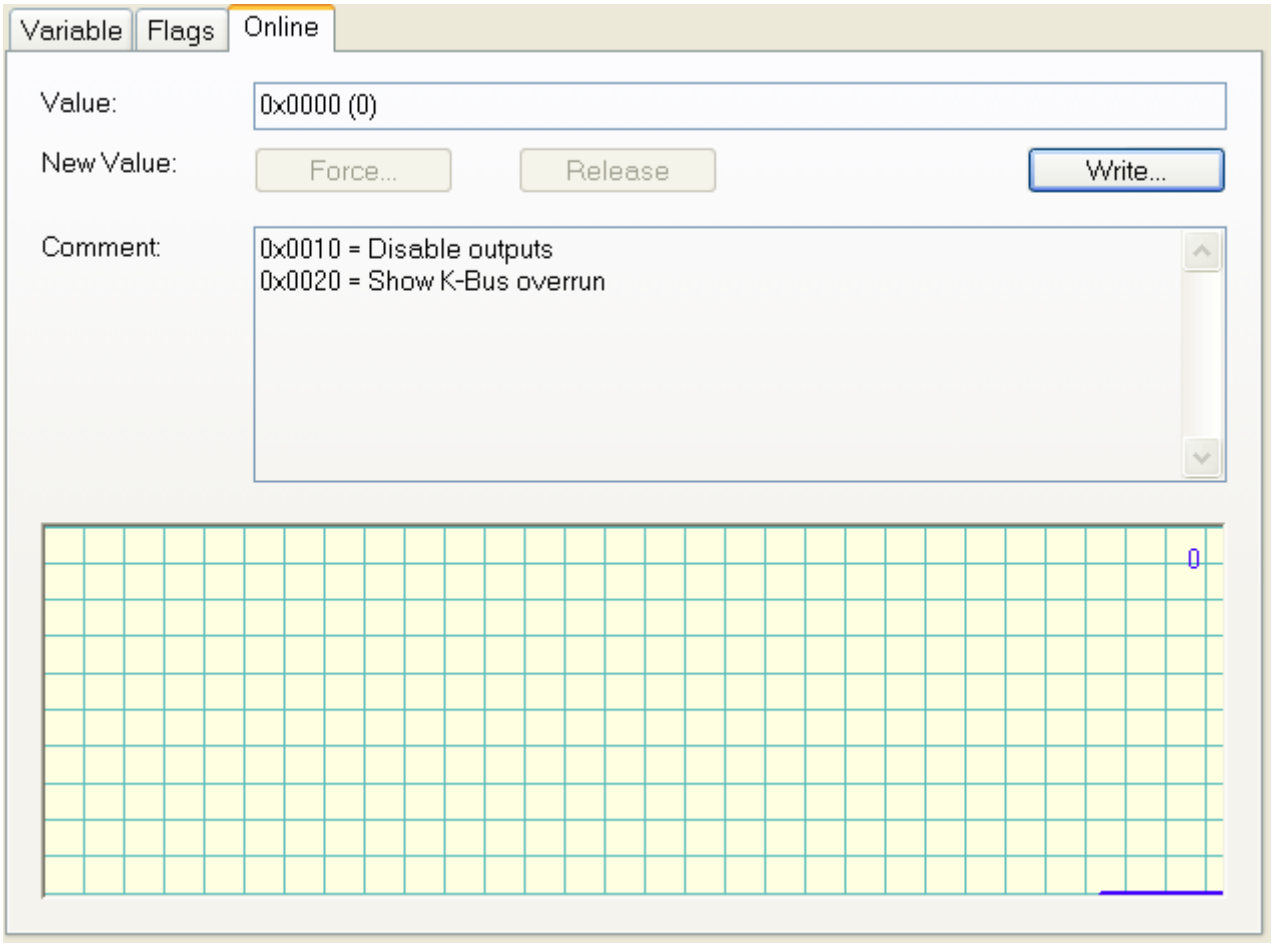


Fig. 4 CouplerCrtl, "Online" tab

Working counter status (WcState)

Working counter status (WcState)

WCstate, "Online" tab

Boolean variable indicating the working counter status of the Fieldbus Box. An invalid working counter (value: 1) is displayed if invalid data were transferred by the EtherCAT slave controller.

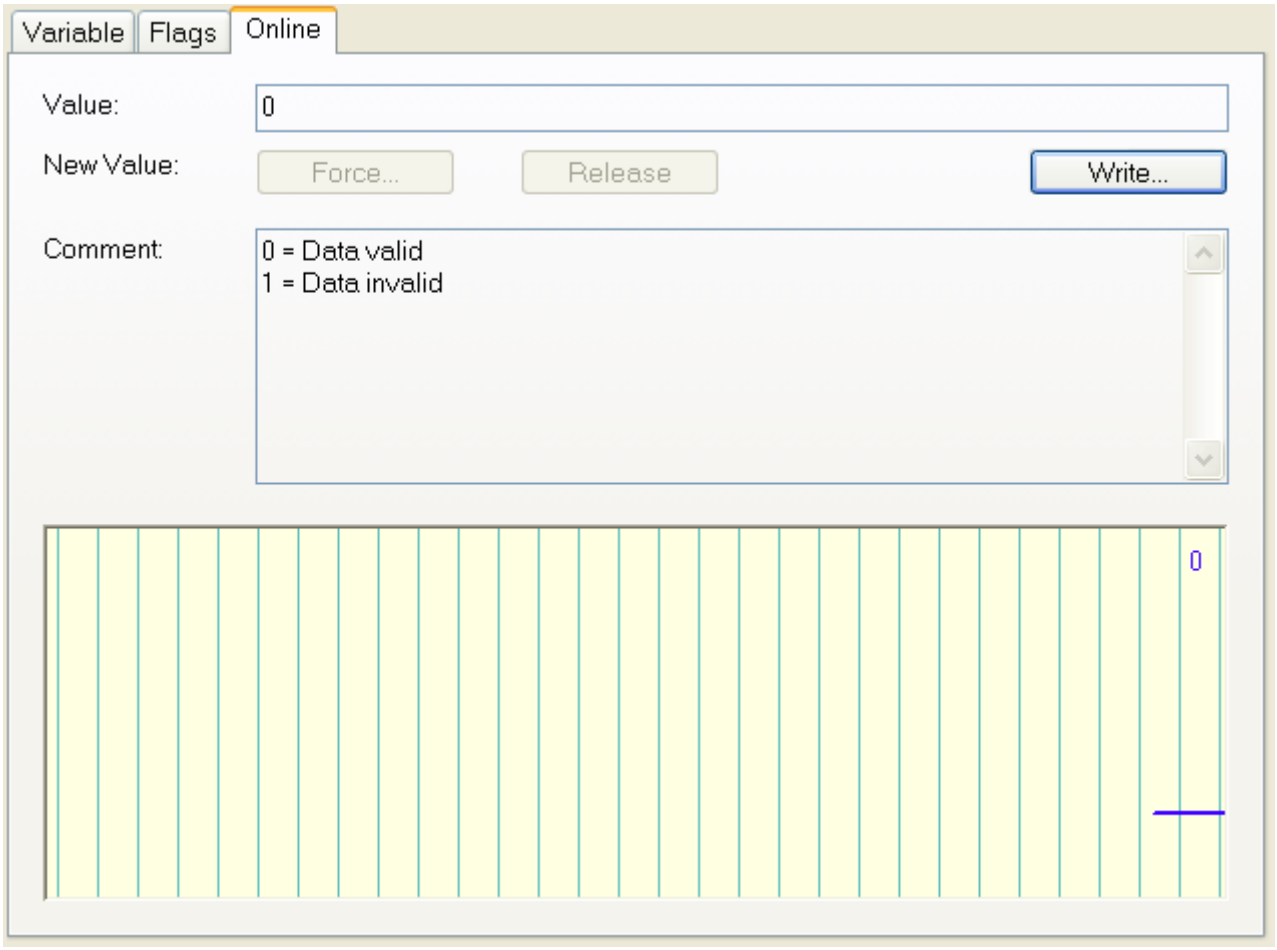


Fig. 5 WCstate, "Online" tab

Online status (Info Data)

Online status (Info Data)

State, "Online" tab

Indicates the online status of the Fieldbus Box.

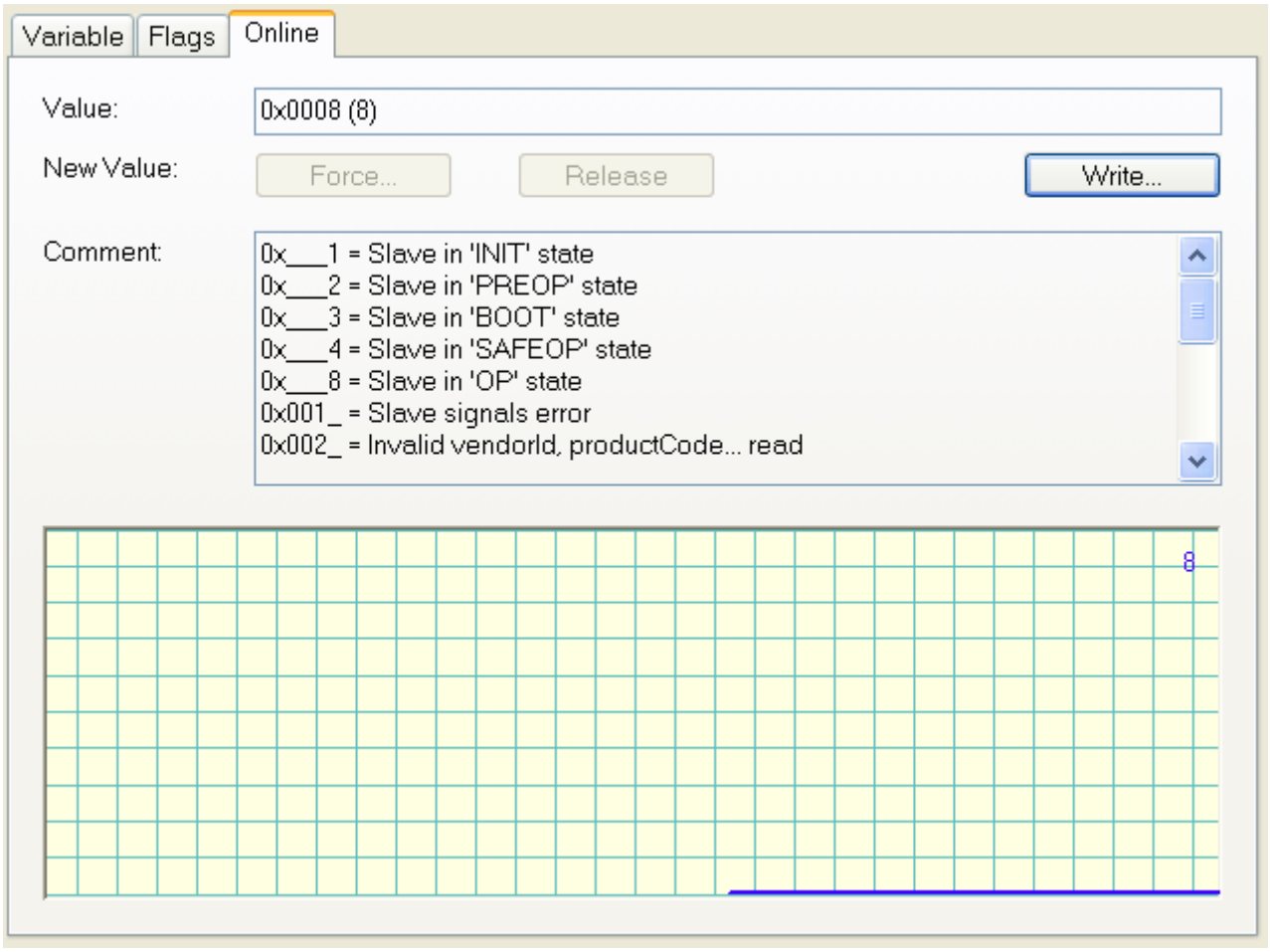


Fig. 6 State, "Online" tab

Value	Description
0x___1	Slave in 'INIT' state
0x___2	Slave in 'PREOP' state
0x___3	Slave in 'BOOT' state
0x___4	Slave in 'SAFEOP' state
0x___8	Slave in 'OP' state
0x001_	Slave signals error
0x002_	Invalid vendorId, productCode... read
0x004_	Initialization error occurred
0x010_	Slave not present
0x020_	Slave signals link error
0x040_	Slave signals missing link
0x080_	Slave signals unexpected link
0x100_	Communication port A
0x200_	Communication port B
0x400_	Communication port C
0x800_	Communication port D

ADS address (ADSAddr)

ADS address (ADSAddr)

ADSAddr, Online tab

Single line indicating the AMS netID and the AMS port of the Fieldbus Box using the hexadecimal system. This information is required for mailbox communication via ADS.

Example

AC 10 07 3F 02 01 (AMS netID) = 172.16.7.63.2.1
03 E9 (port) = 1001_{dec}

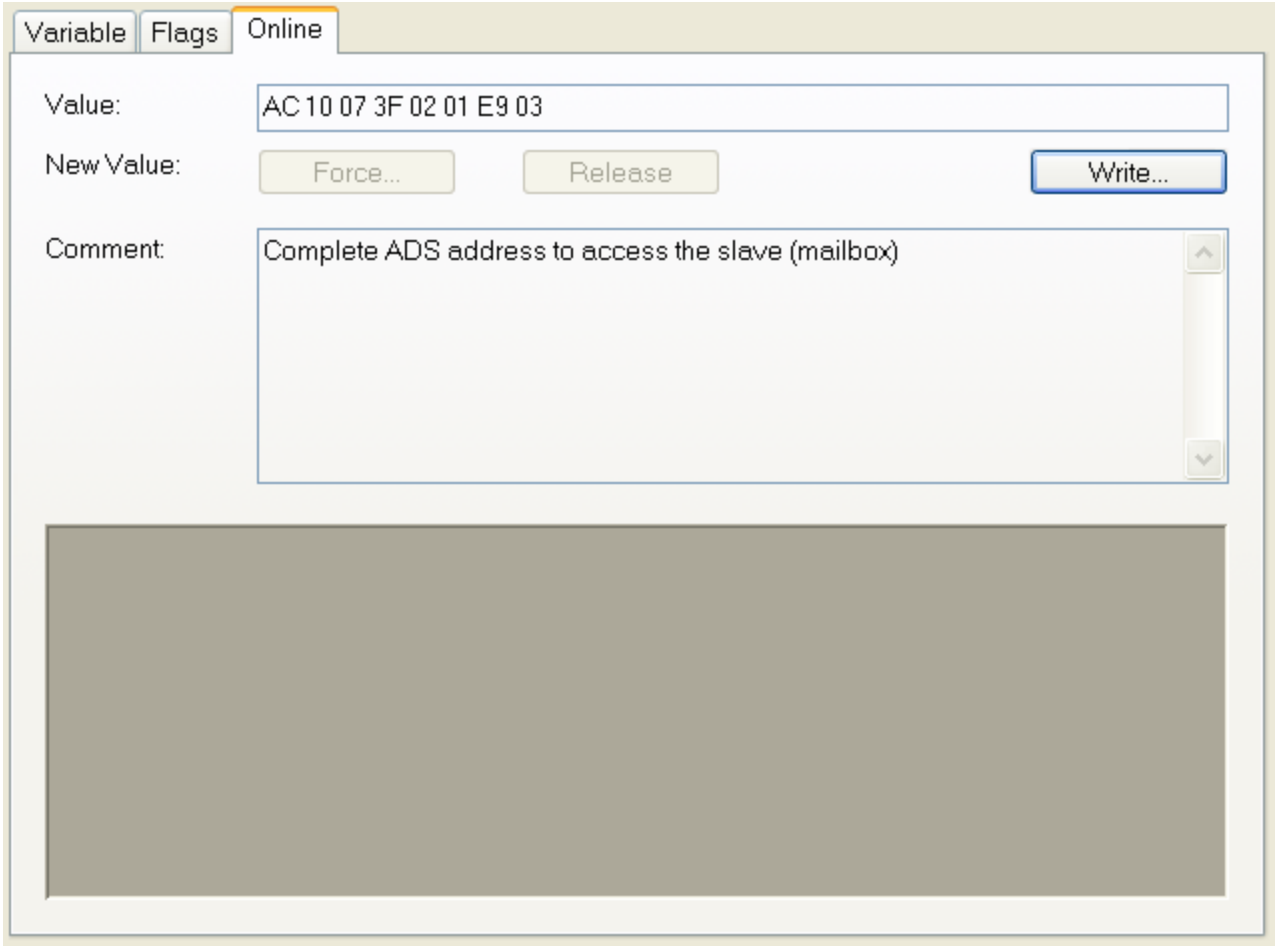


Fig. 7 ADSAddr, "Online" tab

EtherCAT / IP-Link cycle time

EtherCAT / IP-Link cycle time

The IP-Link cycle time resulting from the station configuration with extension box modules is directly displayed in ConfigMode.

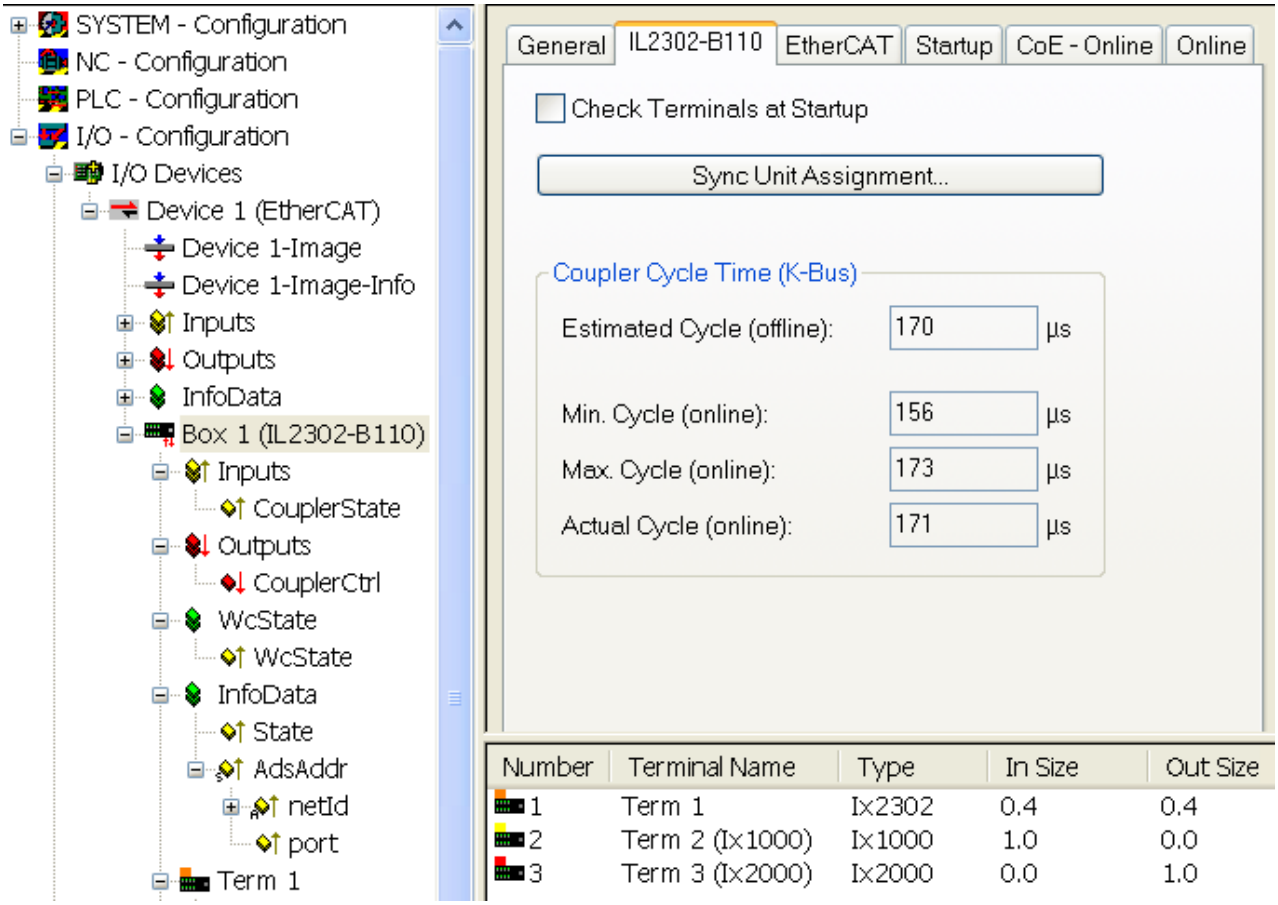


Fig. 8 CycleTime

If the EtherCAT cycle time exceeds the IP-Link cycle time both systems operate in synchronous mode. The IP link is started after an EtherCAT telegram and copies its inputs into the memory. They are retrieved with the next EtherCAT telegram, i.e. the inputs are always exactly one cycle old.

If the EtherCAT cycle is shorter than the IP link cycle, the K-Bus operates asynchronous relative to EtherCAT. Faster polling than "Estimated Cycle (offline)" is therefore possible but may lead to outdated input data or outputs not being set in time via the IP link.

The EtherCAT cycle applied to the IL230x-B110 Fieldbus Box modules should therefore be significantly greater than the "Estimated Cycle (offline)" (min. 250 µs, depending on the configuration). Online control in the system through "Max. Cycle (online)" or "CouplerState" is recommended.

The cycle time can also be read via CoE Online from Table 98 [LO].

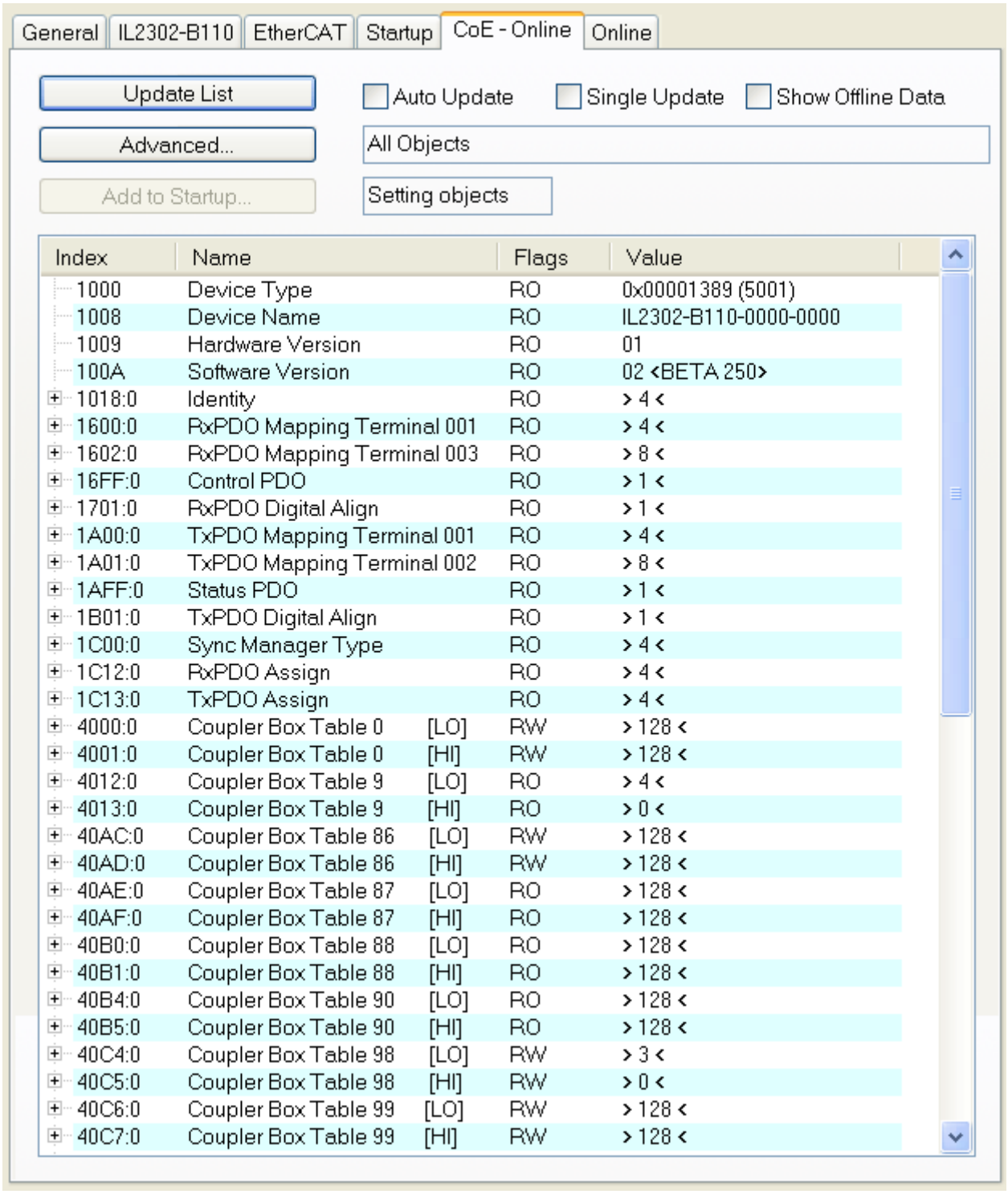
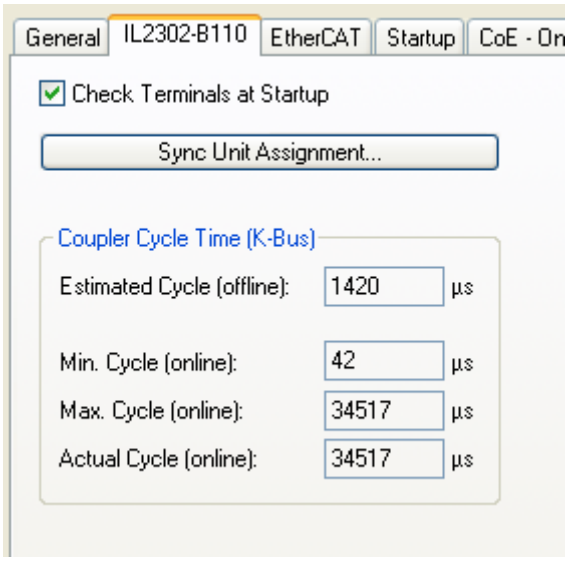


Fig. 9 CycleTime via Table98[LO]

Check of the connected boxes



If you activate "Check Terminals at Startup", at startup is checked if the connected boxes fit to the configured boxes.

6.2 Objects

6.2.1 Object description

Table 1: Extracted nested table 0

Index	Name	Meaning		
6000:0	IE23xx	IE2301, max . Subindex (4)	Signals in Coupler Box: IE2301	Input data
6**00**0:01	Channel 1	1. Channel, IE2301		
6**00**0:02	Channel 2	2. Channel, IE2301		
6**00**0:03	Channel 3	3. Channel, IE2301		
6**00**0:04	Channel 4	4. Channel, IE2301		
6**01**0:0	IE10xx	IE1001, max. Subindex (8)	Position 1 behind Coupler Box: IE1001	
6**01**0:01	Channel 1	1. Channel, IE1001		
6**01**0:02	Channel 2	2. Channel, IE1001		
6**01**0:03	Channel 3	3. Channel, IE1001		
6**01**0:04	Channel 4	4. Channel, IE1001		
6**01**0:05	Channel 5	5. Channel, IE1001		
6**01**0:06	Channel 6	6. Channel, IE1001		
6**01**0:07	Channel 7	7. Channel, IE1001		
6**01**0:08	Channel 8	8. Channel, IE1001		
6**03**0:0	IE3102	IE3102, max. Subindex (12)	Position 3 behind Coupler Box: IE3102	
6**03**0:01	Channel 1 Status	1. Channel, Status, IE3102		
6**03**0:03	Channel 1 Data	1. Channel, Data IE3102		
6**03**0:04	Channel 2 Status	2. Channel, Status, IE3102		
6**03**0:06	Channel 2 Data	2. Channel, Data, IE3102		
6**03**0:07	Channel 3 Status	3. Channel, Status, IE3102		
6**03**0:09	Channel 3 Data	3. Channel, Data, IE3102		
6**03**0:0A	Channel 4 Status	4. Channel, Status, IE3102		
6**03**0:0C	Channel 4 Data	4. Channel, Status, IE3102		

Index	Name	Meaning		
7**00**0:0	IE23xx	IE2301, max . Subindex (4)	Signals in Coupler Box: IE2301	Output data
7**00**0:01	Channel 1	1. Channel, IE2301		
7**00**0:02	Channel 2	2. Channel, IE2301		
7**00**0:03	Channel 3	3. Channel, IE2301		
7**00**0:04	Channel 4	4. Channel, IE2301		
7**02**0:0	IE20xx	IE2001, max . Subindex (8)	Position 2 behind Coupler Box: IE3102	
7**02**0:01	Channel 1	1. Channel, IE2001		
7**02**0:02	Channel 2	2. Channel, IE2001		
7**02**0:03	Channel 3	3. Channel, IE2001		
7**02**0:04	Channel 4	4. Channel, IE2001		
7**02**0:05	Channel 5	5. Channel, IE2001		
7**02**0:06	Channel 6	6. Channel, IE2001		
7**02**0:07	Channel 7	7. Channel, IE2001		
7**02**0:08	Channel 8	8. Channel, IE2001		
7**03**0:0	IE3102	IE3102, max. Subindex (12)	Position 3 behind Coupler Box: IE3102	
7**03**0:01	Channel 1 Control	1. Channel, Control, IE3102		
7**03**0:03	Channel 1 Data	1. Channel, Data IE3102		
7**03**0:04	Channel 2Control	2. Channel, Control, IE3102		
7**03**0:06	Channel 2 Data	2. Channel, Data IE3102		
7**03**0:07	Channel 3 Control	3. Channel, Control, IE3102		
7**03**0:09	Channel 3 Data	3. Channel, Data IE3102		
7**03**0:0A	Channel 4 Control	4. Channel, Control, IE3102		
7**03**0:0C	Channel 4Data	4. Channel, Data IE3102		

Standard objects

Standard objects

Index 1000 Device type

Index 1000

Device type (read only) of the EtherCAT slave.

Index	Name	Meaning	Flags	Default
1000	DeviceType	Device type	RO	0x00001389 (5001_{dec})

Index 1008 Device name

Index 1008

Device name (read only, Value: z. B. IL2302-B110-0000-0000) of the EtherCAT slave.

Index	Name	Meaning	Flags	Default
1008	DeviceName	Device name	RO	e.g. IL2302-B110-0000-0000

Index 1009 Hardware version

Index 1009

Hardware-Version (read only) of the EtherCAT slave.

Index	Name	Meaning	Flags	Default
1009	Hardware Version	Hardware version	RO	e.g. 01

Index 100A Software version

Index 100A

Version (read only, Value: z. B. 01) of the Firmware (processing of the I/O signals) of the EtherCAT slave.

Index	Name	Meaning	Flags	Default
100A	Software version	Software version	RO	e.g. 01

Index 1018 Identity object

Index 1018

Index	Name	Meaning	Flags	Default
1018:0	Identity object	Length of this object	RO	-
1018:01	Vendor id	Vendor id of the EtherCAT slave	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	RO	0x04602C22 (73411618_{dec})
1018:03	Revision number	Revision number of the EtherCAT slave	RO	0x00000000 (0_{dec})
1018:04	Serial number	Serial number of the EtherCAT slave	RO	0x00000000 (0_{dec})

Index 16kk RxPDO Mapping Terminal

Index 16kk

Value range: $(kk = 00...FE)_{hex}$, $[(hh = 01...FF)_{hex}$, $(ddd = 001...255)]_{dec}$

Index	Name	Meaning	Flags	Default
16kk:0	RxPDO Mapping Terminal	Length of this object	RW	-
16kk:01	Output Mapping Area 001	1. output variable of this box (Subindex 001)	RW	z. B. 0x7kk0:01, 1
...	...	...	...	...
16kk:hh	Output Mapping Area ddd	last output variable (Subindex ddd)	RW	e.g. 0x7kk0:hh, 1

Index 16FF Control PDO

Index 16FF

Index	Name	Meaning	Flags	Default
16FF:0	Control PDO	Length of this object	RW	-
16FF:01	Output Mapping Area	Control-word	RW	0xF200:01, 16

Index 1701 RxPDO Digital Align

Index 1701

Index	Name	Meaning	Flags	Default
1701:0	RxPDO Digital Align	Length of this object	RW	-
1701:01	PDO Align	Word Alignment Dummy for Digital RxPDOs	RW	0x0000:00, 12

Index 1Akk TxPDO Mapping Terminal

Index 1Akk

Value range: (kk = 00_{hex}...FE_{hex}), [(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})]

Index	Name	Meaning	Flags	Default
1Akk:0	TxPDO Mapping Terminal	Length of this object	RW	-
1Akk:01	Input Mapping Area 001	1. input variable of this Box (Subindex 001)	RW	z. B. 0x6kk0:01, 1
...	...	...	...	...
1Akk:hh	Input Mapping Area ddd	last input variable of this Box (Subindex ddd)	RW	z. B. 0x6kk0:hh, 1

Index 1AFF Status PDO

Index 1AFF

Index	Name	Meaning	Flags	Default
16FF:0	Status PDO	Length of this object	RW	-
16FF:01	Input Mapping Area	Status-word	RW	0xF100:01, 16

Index 1B01 TxPDO Digital Align

Index 1B01

Index	Name	Meaning	Flags	Default
1B01:0	TxPDO Digital Align	Length of this object	RW	-
1B01:01	PDO Align	Word Alignment Dummy for Digital TxPDOs	RW	0x0000:00, 12

Index 1C00 SM type

Index 1C00

Index	Name	Meaning	Flags	Default
1C00:0	Sync Manager Type	Length of this object	RO	4
1C00:01	Subindex 001	sync manager, parameter 1	RO	0x01 (1_{dec})
1C00:02	Subindex 002	sync manager, parameter 2	RO	0x02 (2_{dec})
1C00:03	Subindex 003	sync manager, parameter 3	RO	0x03 (3_{dec})
1C00:04	Subindex 004	sync manager, parameter 4	RO	0x04 (4_{dec})

Index 1C12 RxPDO Assign

Index 1C12

Value range: [(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})]

Index	Name	Meaning	Flags	Default
1C12:0	RxPDO Assign	Length of this object	RW	-
1C12:01	Subindex 001	assignment of the Control PDO	RW	0x16FF(5887_{dec})
1C12:02	Subindex 002	assignment 1. RxPDO analog boxes	RW	z. B. 0x1603 (5635_{dec})
...	...	...	...	...
1C12:nn	Subindex nnn	assignment n. RxPDO analog boxes	RW	z. B. 0x1605 (5637_{dec})
1C12:(nn+1)	Subindex (nnn+1)	assignment (n+1). RxPDO digital boxes	RW	z. B. 0x1600 (5632_{dec})
...	...	...	...	.....
1C12:hh	Subindex ddd	assignment Word Alignment Dummy for Digital RxPDOs	RW	0x1701(5889_{dec})

Index 1C13 TxPDO Assign

Index 1C13

Value range: [(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})]

Index	Name	Meaning	Flags	Default
1C13:0	TxPDO Assign	Length of this object	RW	-
1C13:01	Subindex 001	assignment of the Control PDO	RW	0x1AFF(6911_{dec})
1C13:02	Subindex 002	assignment 1. TxPDO analog boxes	RW	z. B. 0x1A03 (6659_{dec})
...	...	...	...	...
1C13:nn	Subindex nnn	assignment n. TxPDO analog boxes	RW	z. B. 0x1A05 (6661_{dec})
1C13:(nn+1)	Subindex (nnn+1)	assignment (n+1). TxPDO digital boxes	RW	z. B. 0x1A01 (6657_{dec})
...	...	...	...	.....
1C13:hh	Subindex ddd	assignment Word Alignment Dummy for Digital TxPDOs	RW	0x1B01(6913_{dec})

Device specific objeks

Index 4000 Coupler Box Table 0 [LO]: general configuration of the Fieldbus Box

Index 4000

Index	Name	Meaning	Flags	Default
4000:0	Coupler Box Table 0 [LO]	Length of this object	RW	128
4000:01	Subindex 001	Register 0	RW	
4000:02	Subindex 002	Register 1	RW	
...		...	...	...
4000:80	Subindex 128	Register 127	RW	

Index 4001 Coupler Box Table 0 [HI]: general configuration of the Fieldbus Box (continuation)

Index	Name	Meaning	Flags	Default
4001:0	Coupler Box Table 0 [HI]	Length of this object	RW	128
4001:01	Subindex 001	Register 128	RW	
4001:02	Subindex 002	Register 129	RW	
...	...	...	...	...
4001:80	Subindex 128	Register 255	RW	

Index 4012 Coupler Box Table 9 [LO]: Subordinate Extension Box Modules

Index	Name	Meaning	Flags	Default
4012:0	Coupler Box Table 9 [LO]	Length of this object	RO	max. 128
4012:01	Subindex 001	Register 0: identification of the Fieldbus Box	RO	0x006E (110_{dec}[1])
4012:02	Subindex 002	Register 1: identification of the 1. extension	RO	e.g.: 0x000A (10_{dec}[2])
4012:03	Subindex 003	Register 2: identification of the 2. extension	RO	e.g.: 0x000A (10_{dec}[2])
4012:04	Subindex 004	Register 3: identification of the 3. extension	RO	e.g. 0x0C82 (3202_{dec})
...	...	...	...	...
4012:80	Subindex 121	Register 120: identification of the 120. extension	RO	

[1]) For the Fieldbus Box and intelligent (e.g. analog) extensions the module name is given decimal in clear text e.g. 0x0C82 (3202_{dec}) means IE3202.

[2]) For simple (digital) Extension Box Modules the following coding is given:

Wert	Meaning
0x000A (10)	4 digital inputs and 4 digital outputs
0x0015 (21)	8 digital inputs and 8 digital outputs
0x0035 (53)	8 digital inputs and 8 digital outputs (physical on the same address)
0x0011 (17)	8 digital outputs
0x0014 (20)	8 digital inputs

Index 40AE Coupler Box Table 87 [LO]: IP-Link error place

Index	Name	Meaning	Flags	Default
40AE:0	Coupler Box Table 87 [LO]	Length of this object	RO	128_{dec}
40AE:01	Subindex 001		RO	
40AE:02	Subindex 002		RO	
40AE:03	Subindex 003	number of faulty telegrams at the 1. Extension Box	RO	
40AE:04	Subindex 004	number of faulty telegrams at the 2. Extension Box	RO	
...	...		...	...
40AE:0127	Subindex 127	Register 127: reserved	RO	

Index 40B4 Coupler Box Table 90 [LO]: internal diagnostic information of the Fieldbus Box

Index	Name	Meaning	Flags	Default
40B4:0	Coupler Box Table 90 [LO]	Length of this object	RO	128_{dec}
40B4:01	Subindex 001	reserved	RO	
40B4:02	Subindex 002	reserved	RO	
40B4:03	Subindex 003	error Code	RO	
40B4:04	Subindex 004	error Argument	RO	
...	...	...	...	...
40B4:04	Subindex 128	reserved	RO	

The error code and the argument are similar to the meaning of the Blink-Codes of the Feldbus LEDs [▶ 65].

Index 40C4 Coupler Table 98 [LO]: IP-Link cycle time (µs)

Index	Name	Meaning	Flags	Default
40C4:0	Coupler Table 98 IP-Link Cycle Time (µs)	Length of this object	RW	3
40C4:01	Min IPL time	minimum update time on the IP-Link	RW	-
40C4:02	Max IPL time	maximum update time on the IP-Link	RW	-
40C4:03	Curr IPL time	current update time on the IP-Link	RW	-

Index 427F Extension Box No

Index	Name	Meaning	Flags	Default
427F:0	ExtensionBoxNo	To communicate with the intelligent extension boxes in this object the number of the box has to be inserted. Now the box can be paremeterized by the four following tables (object 4280 - 4287). Count like: the Coupler Box has got Nor. 0. The first extension Box has got no. 1 and so on. Only intelligent boxes (with register set) can be paremeterized!	RW	0

Index 4280 - 4287Terminal Table 0 [LO]: for parameterizing of the box specified by object 427F

Index 4280 - 4287

Index	Name	Meaning	Flags	Default
428x:0	ExtensionBox Channel 0 ... 3	Length of this object	RW	64
428x:01	Subindex 001	Register 0	RW	0x0000 (0_{dec})
428x:02	Subindex 002	Register 1	RW	0x0000 (0_{dec})
...	...	...	...	...
428x:40	Subindex 064	Register 63	RW	0x0000 (0_{dec})

Index 6xxx and 7xxx Process Data

Index 6xxx and 7xxx

At index 6xxx and 7xxx the process data of the Extension Boxes is displayed. The sequence is equal to the physical sequence within the IP-Ling ring. The indices are counted in steps by 10, that means e.g. 6000, 6010, 7020, 7030, 6040... if the dedicated module has only inputs or outputs. If it has inputs and outputs like e.g. an IE2301 (on the Coupler Box) the index 6000 as also the index 7000 exists.

Dynamic generation of the input and output objects

The vValue range of the "kk", "hh", and "ddd" variables from the input and output indices are showed below. The dynamic generation of the input and output objects depends on the sequence of the Extension Box Modules within the whole Fieldbus Box station.Example of a Fieldbus Box StationIL2301-B110 - IE1001- IE2001- IE3102; EtherCAT respectively the Coupler Box doesn't differ the digital Boxes from their different connection types, so e.g. an IE2301 is displayed as IE23xx.Mapping of the assigned PDOs (from Index 6000):see "Extracted nested table 0"

Index 6kk0 Process Input Data

Index 6kk0

Digital Extension Boxes:

Value range:
(kk = 00_{hex}...FF_{hex}),
[(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})]

Index	Name	Meaning	Flags	Default
6kk0:0	Process Input Data	[Module identification]	RO P	-
6kk0:01	Channel 001	Channel 001	RO P	-
...	...	...	...	...
6kk0:hh	Channel ddd	Channel ddd	RO P	-

Not Digital Extension Boxes (for hh ≥ 03; ddd ≥ 003):

Value range:
(kk = 00_{hex}...FF_{hex}),
[(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})] for integer by 3 divisible values hh respectively ddd

Index	Name	Meaning	Flags	Default
6kk0:0	Process Input Data	[Module name]	RO P	-
6kk0:01	Channel 001 Status	Channel 001: Status	RO P	-
6kk0:02	Channel 001 Word-Alignment	Channel 001: Word-Alignment	RO P	-
6kk0:03	Channel 001 Data	Channel 001: Data	RO P	-
...	...	...	...	...
6kk0:hh-2	Channel ddd/3	Channel ddd/3: Status	RO P	-
6kk0:hh-1	Channel ddd/3	Channel ddd/3: Word-Alignment	RO P	-
6kk0:hh	Channel ddd/3	Channel ddd/3: Data	RO P	-

Index 7kk0 Process Output Data

Digital Extension Boxes:

Value range:
(kk = 00_{hex}...FF_{hex}),
[(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})]

Index	Name	Meaning	Flags	Default
7kk0:0	Process Output Data	[Module identification]	RO P	-
7kk0:01	Channel 001	Channel 001	RO P	-
...	...	...	...	...
7kk0:hh	Channel ddd	Channel ddd	RO P	-

Not Digital Extension Boxes (for hh ≥ 03; ddd ≥ 003):

Value range:
(kk = 00_{hex}...FF_{hex}),
[(hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})] for integer by 3 divisible values hh respectively ddd

Index	Name	Meaning	Flags	Default
7kk0:0	Process Input Data	[Module name]	RO P	-
7kk0:01	Channel 001 Ctrl	Channel 001: Control	RO P	-
7kk0:02	Channel 001 Word-Alignment	Channel 001: Word-Alignment	RO P	-
7kk0:03	Channel 001 Data	Channel 001: Data	RO P	-
...	...	...	...	...
7kk0:hh-2	Channel ddd/3 Ctrl	Channel ddd/3: Control	RO P	-
7kk0:hh-1	Channel ddd/3 Word-Alignment	Channel ddd/3: Word-Alignment	RO P	-
7kk0:hh	Channel ddd/3 Data	Channel ddd/3: Data	RO P	-

Index 9kk0 Slave Info Data

Index 9kk0

Value range: (kk = 00_{hex}...FF_{hex})

Index	Name	Meaning	Flags	Default
9kk0:0	Slave Info Data	[Module name]	RO	-
9kk0:01	Position	Module position within combination	RO	-
9kk0:09	Module PDO Group	Module PDO group • not-Digital Extension Boxes: group 1 • Digital Extension Boxes: group 2	RO	-
9kk0:0A	Module Ident	Module identification [▶ 42]	RO	-

Index F000 Modular Device Profile

Index F000

Index	Name	Meaning	Flags	Default
F000:0	Modular Device Profile	Length of this object	RO	5
F000:01	Module Index Distance	distance module index	RO	0x0010 (16_{dec})
F000:02	Maximum Number of Modules	Max. number of IP-Link Modules	RO	0x0079 (121_{dec})
F000:03	Standard Entries in Object 0x8yy0	possible entries in object 0x8kk0	RO	0x0000000 (0_{dec})
F000:04	Standard Entries in Object 0x9yy0	possible entries in object 0x9kk0	RO	0x0000000 (0_{dec})
F000:04	Module PDO Group	Module PDO group of the device = 0, (Control and status data is mapped in front of the process data	RO	0x00 (0_{dec})

Index F00E Group Alignment PDO

Index F00E

Index	Name	Meaning	Flags	Default
F00E:0	Group Alignment PDO	Length of this object (3 PDO box groups)	RO	3
F00E:01	Subindex 001	group 0: no alignment necessary	RO	0x0000 (0_{dec})
F00E:02	Subindex 002	group 1: Alignment PDO (PDO 257) for PDO group 1 (not-digital Extension Boxes)	RO	0x0100 (256_{dec})
F00E:03	Subindex 003	group 2: Alignment PDO (PDO 258) for PDO group 2 (digital Extension Boxes)	RO	0x0101 (257_{dec})

Index F00F Module Group Mapping Alignment

Index F00F

Index	Name	Meaning	Flags	Default
F00F:0	Module Group Mapping Alignment	Length of this object (3 PDO module groups)	RO	3
F00F:01	Subindex 001	group 0: no alignment for PDO group 0 necessary, Control- and status data is fix	RO	0x0000 (0_{dec})
F00F:02	Subindex 002	group 1: word-Alignment for PDO group 1 (not-digital Extension Boxes). The following process data of the extension boxes is always mapped to an even byte address	RO	0x0002 (2_{dec})
F00F:03	Subindex 003	group 2: word-Alignment for PDO Gruppe 2 (digital Extension Boxes). The process data size of digital extension boxes is always even.	RO	0x0002 (2_{dec})

Index F010 Module List

Index F010

Value range: (hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})

Index	Name	Meaning	Flags	Default
F010:0	Module List	Length of this object	RO	-
F010:01	Subindex 001	Name Module [▶ 42] 001	RO	-
...	...	...	...	...
F010:hh	Subindex ddd	Name Module [▶ 42] ddd	RO	-

Index F030 Configured Module List

Index F030

Value range: (hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})

Index	Name	Meaning	Flags	Default
F030:0	Module List	Length of this object	RW	-
F030:01	Subindex 001	Box name of the configured extension box at position 1 (value like 0x8kk0:0A)	RW	-
...	...	...	...	...
F030:hh	Subindex ddd	Box name of the configured extension box at last position (value like 0x8kk0:0A)	RW	-

Index F040 Detected Address List

Index F040

Value range: (hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})

Index	Name	Meaning	Flags	Default
F040:0	Module List	Length of this object	RO	-
F040:01	Subindex 001	Position oft he first extension box (value like0x9kk0:01 [▶ 46])	RO	0x0001 (1_{dec})
...	...	...	...	...
F040:hh	Subindex ddd	Position of the last extension box (value like0x9kk0:01 [▶ 46])	RO	0x00hh (ddd_{dec})

Index F050 Detected Module List

Index F050

Value range: (hh = 01_{hex}...FF_{hex}), (ddd = 001_{dec}...255_{dec})

Index	Name	Meaning	Flags	Default
F050:0	Module List	Length of this object	RO	-
F050:01	Subindex 001	identification of the extension box an position 1 (value like 9kk0:0A [▶ 46])	RO	-
...	...	...	...	...
F050:hh	Subindex ddd	identification of the extension box at last position (value like9kk0:0A [▶ 46])	RO	-

Index F100 Status PDO

Index F100

Index	Name	Meaning	Flags	Default
F100:0	Status PDO	Length of this object	RO	1
F100:01	CouplerState	Coupler Status-Word	RO P	0x0000 (0_{dec})

Index F200 Control PDO

Index F200

Index	Name	Meaning	Flags	Default
F100:0	ControlPDO	Length of this object	RO	1
F100:01	CouplerCtrl	Coupler Control-Word	RO P	0x0000 (0_{dec})

Also see about this

Object description [▶ 45]

6.3 Configuration of the complex modules

6.3.1 General Register Description

Different operating modes or functionalities may be set for the complex modules. The *General Description of Registers* explains those register contents that are the same for all complex modules. The module-specific registers are explained in the following section.
Access to the module's internal registers is described in the section on *Register Communication*.

General Description of Registers

Complex modules that possess a processor are able to exchange data bi-directionally with the higher-level controller. These modules are referred to below as intelligent modules. These include the analog inputs (0-10 V, -10-10 V, 0-20 mA, 4-20 mA), the analog outputs (0-10 V, -10-10 V, 0-20 mA, 4-20 mA), the serial interface terminals (RS485, RS232, TTY, data exchange terminals), counter terminals, encoder interface and SSI interface terminals, PWM terminals and all the modules that can be parameterized.

The main features of the internal data structure are the same for all the intelligent modules. This data area is organized as words, and includes 64 memory locations. The important data and the parameters of the module can be read and set through this structure. It is also possible for functions to be called by means of corresponding parameters. Each logical channel in an intelligent module has such a structure (so a 4-channel analog module has 4 sets of registers).

This structure is divided into the following areas:

Range	Address
Process variables	0-7
Type register	8-15
Manufacturer parameters	16-30
User parameters	31-47
Extended user region	48-63

Registers R0-R7 (in the terminal's internal RAM)

The process variables can be used in addition to the actual process image. Their function is specific to the terminal.

R0-R5

The function of these registers depends on the type of terminal.

R6

Diagnostic register. The diagnostic register can contain additional diagnostic information. Parity errors, for instance, that occur in serial interface terminals during data transmission are indicated here.

R7

Command register
- High-Byte_Write = function parameter
- Low-Byte_Write = function number
- High-Byte_Read = function result
- Low-Byte_Read = function number

Registers R8-R15 (in the terminal's internal ROM)

The type and system parameters are hard programmed by the manufacturer, and the user can read them but cannot change them.

R8

Fieldbus Box type: The Fieldbus Box type in register R8 is needed to identify the Fieldbus Box.

R9

Software version x.y.: The software version can be read as a string of ASCII characters.

R10

Data length: R10 contains the number of multiplexed shift registers and their length in bits. The Bus Coupler sees this structure.

R11

Signal channels: Related to R10, this contains the number of channels that are logically present. Thus for example a shift register that is physically present can perfectly well consist of several signal channels.

R12

Minimum data length: The particular byte contains the minimum data length for a channel that is to be transferred. If the MSB is set, the control/status byte is not absolutely necessary for the terminal's function, and if the Bus Coupler is appropriately configured it is not transferred to the controller. The information is located
- in the high byte of an output module
- in the low byte of an input module

R13

Data type register

Data type register	Description
0x00	Terminal with no valid data type
0x01	Byte array
0x02	Structure 1 byte n bytes
0x03	Word array
0x04	Structure 1 byte n words
0x05	Double word array
0x06	Structure 1 byte n double words
0x07	Structure 1 byte 1 word
0x08	Structure 1 byte 1 double word
0x11	Byte array with variable logical channel length
0x12	Structure 1 byte n bytes with variable logical channel length (e.g. 60xx)
0x13	Word array with variable logical channel length
0x14	Structure 1 byte n words with variable logical channel length
0x15	Double word array with variable logical channel length
0x16	Structure 1 byte n double words with variable logical channel length

R14

reserved

R15

Alignment bits (RAM): The analog terminal is placed on a byte boundary in the K-Bus with the alignment bits.

Registers R16-R30 (manufacturer's parameters, serial EEPROM)

The manufacturer parameters are specific for each type of terminal. They are programmed by the manufacturer, but can also be modified by the controller. The manufacturer parameters are stored in a serial EEPROM in the terminal, and are retained in the event of voltage drop-out. These registers can only be altered after a code-word has been set in R31.

Registers R31-R47 (application parameters, serial EEPROM)

The application parameters are specific for each type of terminal. They can be modified by the programmer. The application parameters are stored in a serial EEPROM in the terminal, and are retained in the event of voltage drop-out. The application region is write-protected by a code-word.

R31

Code-word register in RAM: The code-word 0x1235 must be entered here so that parameters in the user area can be modified. If any other value is entered into this register, the write-protection is active. If write protection is inactive, the code-word is returned when the register is read, but if write protection is active, then the register contains a null value.

R32

Feature register: This register specifies the terminal's operating modes. Thus, for instance, a user-specific scaling can be activated for the analog I/O modules.

R33-R47

Terminal-specific Registers: These registers depend on the type of terminal.

Registers R47-R63 (Register extension for additional functions)

These registers are provided for additional functions.

6.3.2 Example for Register Communication

Control Byte

The Control Byte is located in the output image, and can be read or written.

Bit	7	6	5	4	3	2	1	0
Name	REG	R/W	register number					

Bit	Name	Description	
7	REG	1_{bin}	Register Communication switched on: The first two Data Bytes are not used for process data exchange, but are written to the register set of the Fieldbus Box or are read from there.
6	R/W	0_{bin}	Read: the register should be read without changing it.
		1_{bin}	Write: the register should be written.
5-0	register number	Number of the Registers, that should be read or written. 64 Registers are addressable.	

Status Byte

The Status-Byte is located in the output image und can only be read.

Bit	7	6	5	4	3	2	1	0
Name	REG	R	register number					

Bit	Name	Description	
7	REG	1_{bin}	receipt register number
6	R	0_{bin}	Read
5-0	register number	Number of the Registers, that was read or written.	

Example 1

Table 2: Reading register 8 of KL3204 or IP/IE3202

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0x88 (1000 1000_{bin})	0xXX	0xXX

Bit 0.7 set indicates register communication active
Bit 0.6 not set indicates reading the register.
Bit 0.5 to Bit 0.0 indicates with 001000_{bin} the register number 8.
The output data word (Byte 1 and Byte 2) has no function at the reading access. If you want to change a register, you have to write the desired value into the output data word.

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0x88	0x0C	0x84

The terminal/box returns the type name 0x0C84 (equivalent unsigned integer 3204) in the input data word (Byte 1 and Byte 2).

Special feature in the naming of Fieldbus Boxes:
The last figure of the delivered unsigned Integer (3204) is not the same like the last character of the Fieldbus Box name (3202), witch stands for the connector type (0 for S8, 1 for M8 and 2 for M12). It returns instead of that the number of channels (IE3204 owns 4 channels).

User code word

In order to write into registers, you have to write the user code word (0x1235) into register 31, so that write protection is deactivated. It is activated again by writing any value other than 0x1235. Note that some of the settings that can be made in registers only become active after the next power restart (power-off/power-on) of the module.

Example 2

Process of register communication for writing into register.

Table 3: 1. Write register 31 (set code word)

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0xDF	0x12	0x35

Answer of the module/terminal

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0x9F	0xXX	0xXX

Table 4: 2. Read register 31 (verify, if code word is set)

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0x9F	0xXX	0xXX

Answer of the module/terminal

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0x9F	0x12	0x35

⚠ CAUTION

Pay attention to the register description!

The given value 0x0002 is only an example! The bits of the feature register change the properties of the module und and have different meanings, depending on the module type. Please check the description of the feature register of your module (chapter register description) about the meanings of the bits in detail, before changing the values!

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0xE0	0x00	0x02

Answer of the module/terminal

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0xA0	0xXX	0xXX

Table 5: 4. Read Register 32 (verify changed register)

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0xA0	0xXX	0xXX

Answer of the module/terminal

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0xA0	0x00	0x02

Table 6: 5. Write Register 31 (set code word back)

Byte 0 (control byte)	Byte 1 (data out, high byte)	Byte 2 (data out, low byte)
0xDF	0x00	0x00

Answer of the module/terminal

Byte 0 (status byte)	Byte 1 (data in, high byte)	Byte 2 (data in, low byte)
0x9F	0xXX	0xXX

6.4 ADS communication

6.4.1 Parameterization example with KS2000

The KS2000 configuration software is used for planning, parametering and commissioning Bus Couplers and Bus Terminals. It can be downloaded from the Beckhoff website under KS2000 Update.

Help for installation and operation is available under KS2000 Documentation in the download area.

The following example describes how to set up communication via ADS with a IL2302-B110. The AmsServerNetId of the target system is required for this purpose.

Step 1

In the TwinCAT System Manager select the required coupler (IL2302-B110), select the "EtherCAT" tab, and click on "Advanced Settings" (Fig. 1).

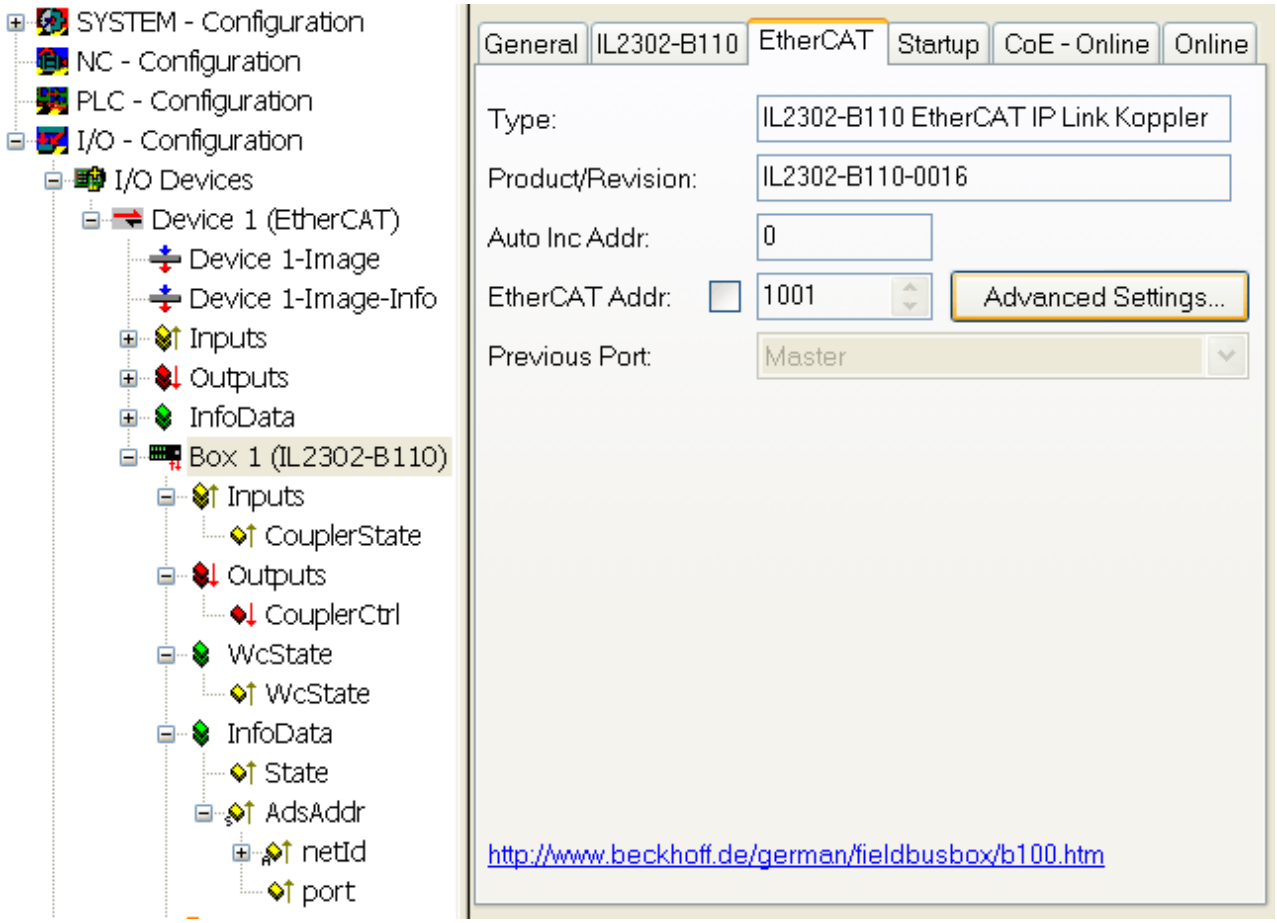


Fig. 1: TwinCAT System Manager: EtherCAT tab for IL2302-B110 box

Step 2

Under "Mailbox", "AoE" (ADS over EtherCAT) select "Generate NetID" and "Initialize NetID". Confirm with *OK*.

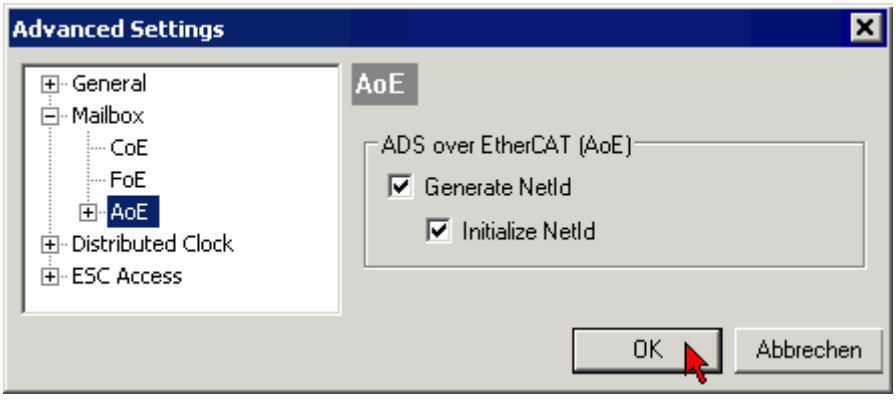


Fig. 2: "EtherCAT" dialog, "Advanced Settings", "AoE"

Step 3

After the KS2000 software has been started and the ADS communication channel has been activated ("Options", "Communication channel", "ADS"), enter the AmsServerNetId (Fig. 3) shown in the TwinCAT System Manager under "Mailbox", "ADS Info" in the pull-down menu of the "ADS" tab (Fig.4):

- **Existing device:** If you select an existing device under Name **(1)**, the AmsServerNetId **(2)** is entered automatically. The AdsPort setting (“100”) **(3)** should not be changed. Click on *Test***(4)** to check the connection settings.

- **User Defined:** For User Defined the AmsServerNetId has to be entered manually **(2)**. Click on *Test*(**4**) to check the connection settings.

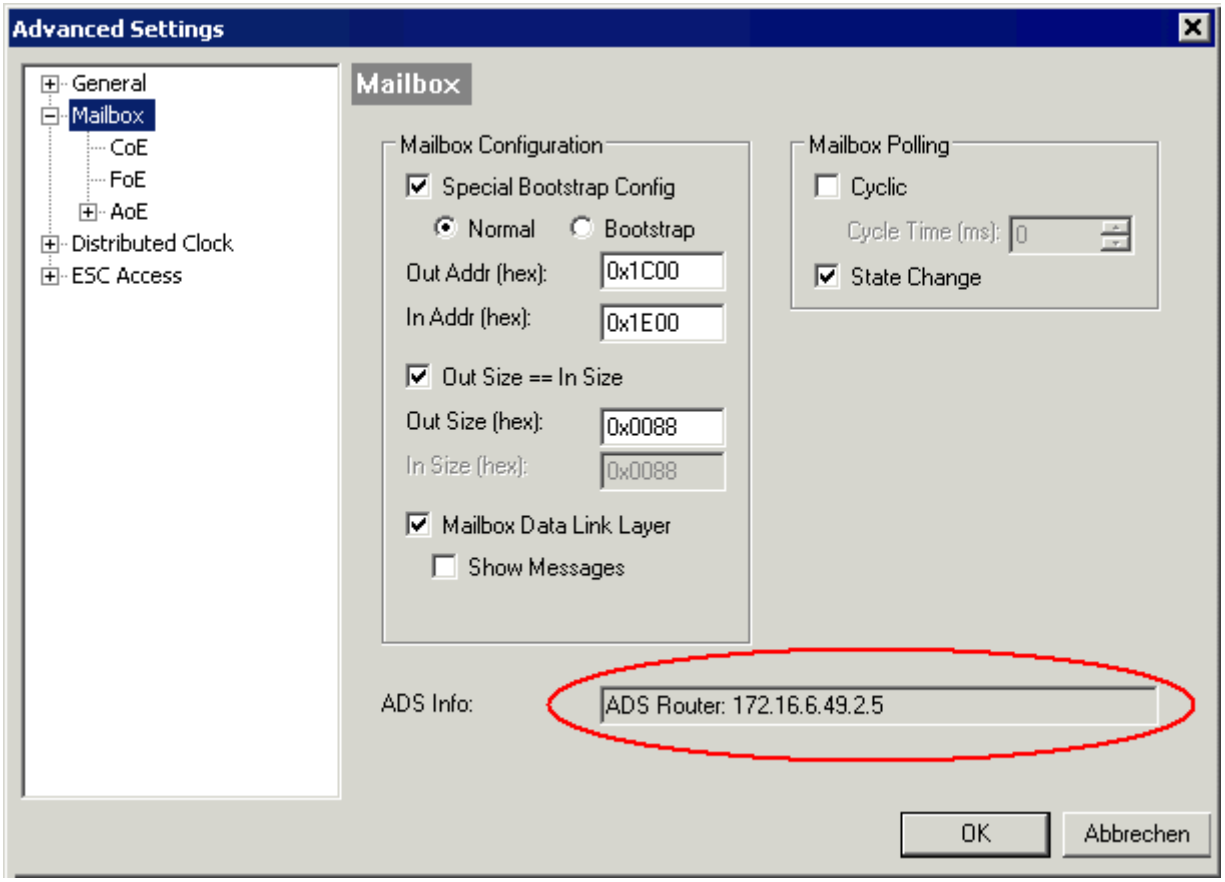


Fig. 3: TwinCAT System Manager: "Mailbox" dialog, transfer of AmsServerNetID

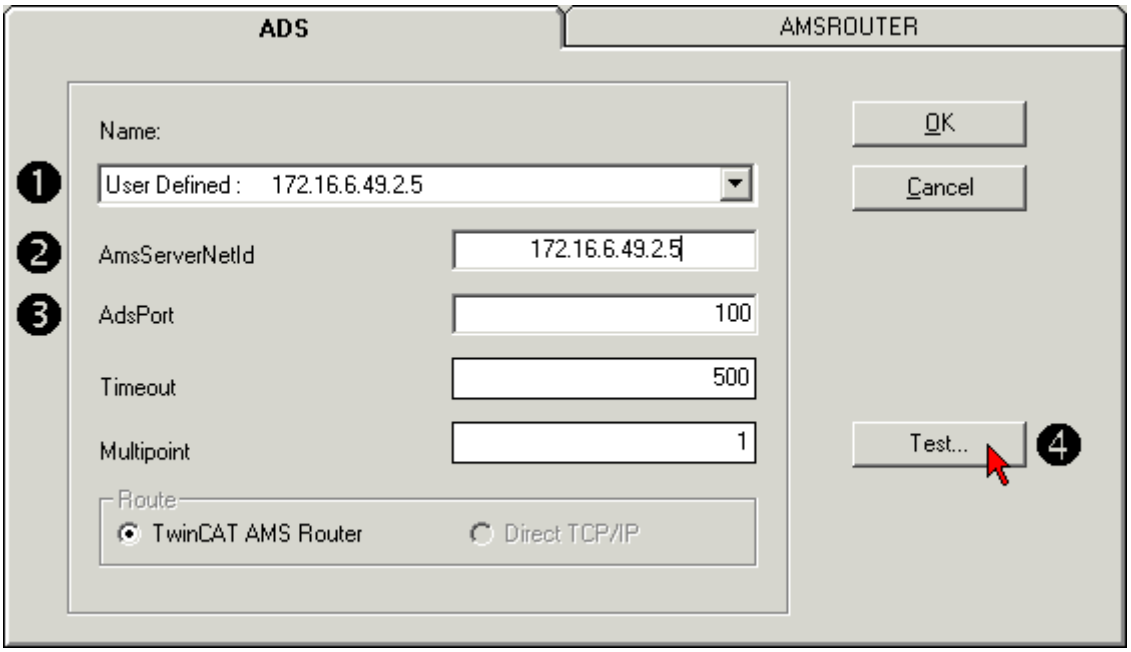


Fig. 4: KS2000: "ADS" tab, enter the AmsServerNetID

Step 4

The test was successful if the following dialog box appears (Fig. 5). Click *OK* to close the dialog box.

Fig. 5: KS2000: Confirmation of successful communication test

Step 5

Click *OK* to accept the set values (Fig.4).

Step 6

Log into the KS2000 system (see also KS2000 Documentation). Parameterization can now be carried out according to the Bus Terminal configuration. Further information can be found in the associated terminal documentation.

7 Error handling and diagnosis

7.1 Diagnostic LEDs - Overview

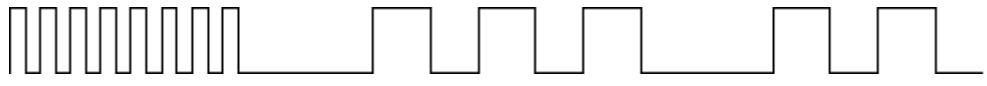
Error diagnosis

There are 2 sorts of errors:

- Fieldbus Errors [▶ 62]
- Local Errors [▶ 65] on Compact Box or Coupler Box

Blink Codes

Blink sequence	Meaning
Fast flashing	Beginning of the Blink Code
first slow sequence	Error code
second slow sequence	Error argument
third slow sequence (optional)	Error argument



Beginning Error code Error argument

7.2 Diagnostic LEDs

After switching on, the module immediately checks the connected configuration. Error-free start-up is indicated when the red *I/O ERR* LED goes out. If the *I/O ERR* LED blinks, an error in the area of the terminals is indicated. The error code can be determined from the frequency and number of blinks. This delivers a fast error elimination.

The module has two groups of LEDs for the display of status.
The upper group with four LEDs indicates the status of the respective fieldbus. The significance of the fieldbus status LEDs is explained in the appropriate sections of this manual. It corresponds to the usual fieldbus display.

At the lower end of the Module are two more green LEDs that indicate the supply voltage. The left hand LED indicates the presence of the 24 V_{DC} supply for the Fieldbus Box. The right hand LED indicates the supply voltage of the outputs.

The LEDs ACT and ERR are reserved and have no meaning at this time.

Fig. 2: B110_ECAT_LED

LEDs for fieldbus diagnosis

LED	Display	Status	Meaning
LINK IN	off	-	no connection with the previous EtherCAT client
	on	linked	previous EtherCAT-client connected
	blinking	active	communication with the previous EtherCAT client
LINK OUT	off	-	no connection with the next EtherCAT client
	on	linked	next EtherCAT client connected
	blinking	active	communication with the next EtherCAT client
ACT	-	-	reserved
ERR	-	-	reserved

LEDs for EtherCAT State Machine / PLC diagnosis

LED		Display	Status	Meaning
RUN	green	off	Init	State of the EtherCAT Fieldbus Box: INIT = *Initialization*
		blinking	Pre-Operational	State of the EtherCAT Fieldbus Box: *PREOP* = *Pre-Operational*
		single flash	Safe-Operational	State of the EtherCAT Fieldbus Box: *SAFEOP* = *Safe-Operational*
		on	Operational	State of the EtherCAT Fieldbus Box: *OP* = *Operational*
		flickers	Bootstrap	State of the EtherCAT Fieldbus Box: *BOOT* = *Bootstrap (*Update of the coupler firmware)
ERROR	red	off	-	no error
		blinking	Err-Operational No Communication	PLC error / Lost Frames

Fig. 3: FBB_power_LED

LEDs for power supply diagnosis

LED	Meaning
left LED off	Module has no operating voltage
left LED red	Short circuit detection for sensor supply has released (> 500mA). Sensors / inputs are not supplied.
right LED off	No power supply 24 V_{DC} for outputs connected

7.3 Diagnostic LEDs for local errors

Local error in a Coupler Box (IL230x-Bxxx/Cxxx)

The term *local error* means that an error has occurred in the Fieldbus Box or the IP-Link. IP-Link errors most often turn out to be a result of inappropriate use of the optical fiber.

LED green	LED red			Description	Remedy
off	off			No data exchange	Module in synchronous mode or - activate PROFIBUS cyclic data
off	1	0		EEPROM checksum error	Set manufacturer's setting with the KS2000 software
off	2			Reserved	-
off	3			Break location has been recognized	interruption before the master's receiver
	3	n		Break location has been recognized	n-th module before the master's receiver
	3	n	m	Break location has been recognized	(n*10)+m-th module before the master's receiver
off	4	n		Too many faulty telegrams have been detected (more than 25%)	The optical fiber wiring in front of the nth extension module should be checked
off	5	n		Register access to complex modules has failed	Check the nth module
off	11	n		Complex module working incorrectly	Exchange the nth module
off	12	n		More than 120 modules in the ring	Connect fewer modules
off	13	n		nth module unknown	Firmware update required
on	off			Module is exchanging data	no error

Local errors in an Extension Box

LED green	LED red	Description
off	on	No data is being received over the IP-Link
off	blinks, flickers	Faulty IP-Link protocols are being received (very poor data connection)
blinks, flickers	blinks, flickers	Faulty IP-Link protocols are being received (poor data connection), does not necessarily lead to an error
on	off	IP-Link protocols are being received, no error

Faulty protocols can occur, because of:

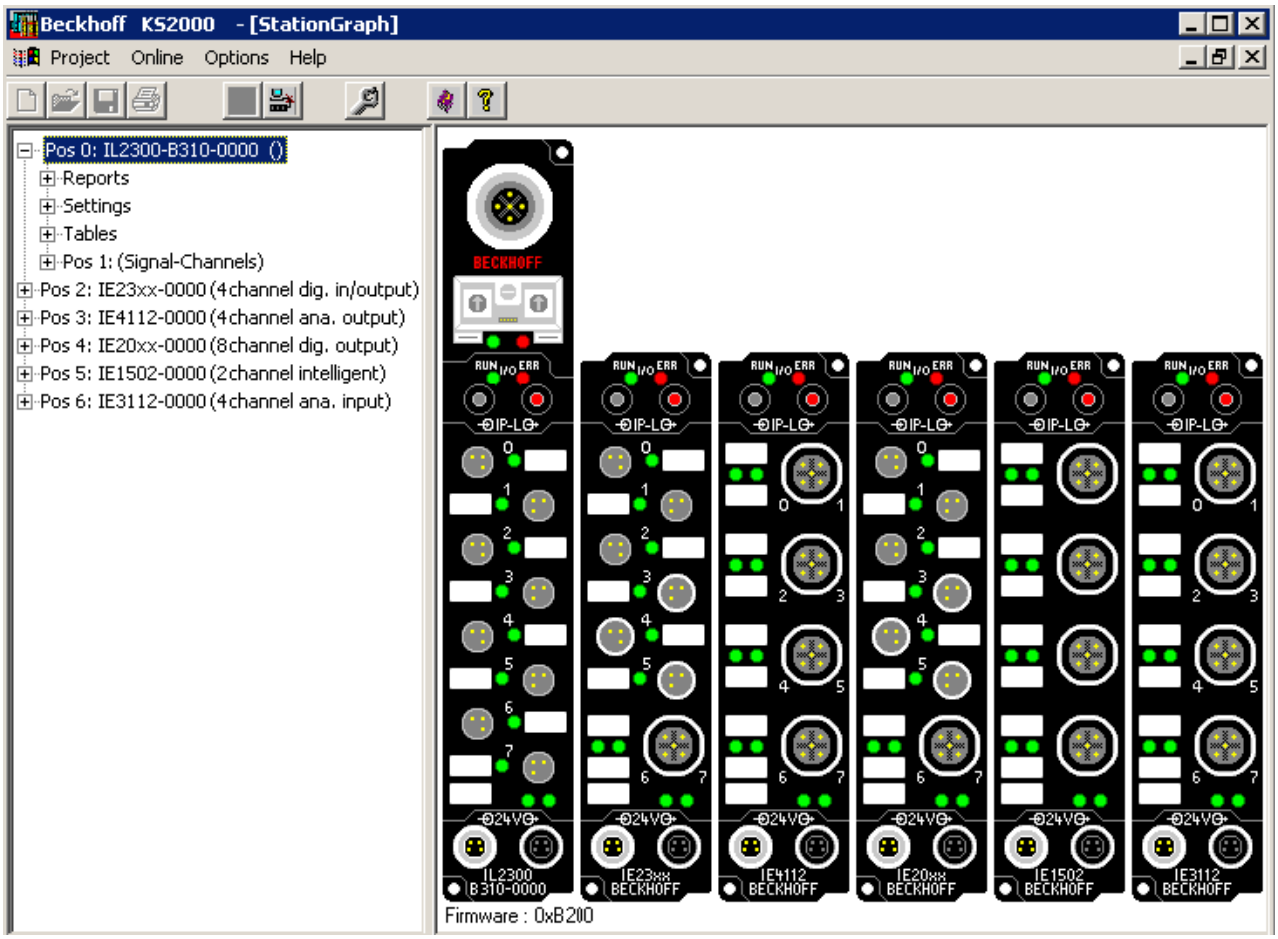
- bad configured IP-Link connectors
- IP-Link cable with higher dampening, e.g. because of a sharp curve
- contaminated sender LED (module before the faulty one)
- contaminated receiver

The internal IP-Link error counter of the Coupler Box can be read with the KS2000 software.

7.4 Check of the IP-Link connection

A correct assembled IP-Link cable will assure an error free transmission.

An additional testing of the transmission quality and error diagnostics is possible with the KS2000 configuration software.



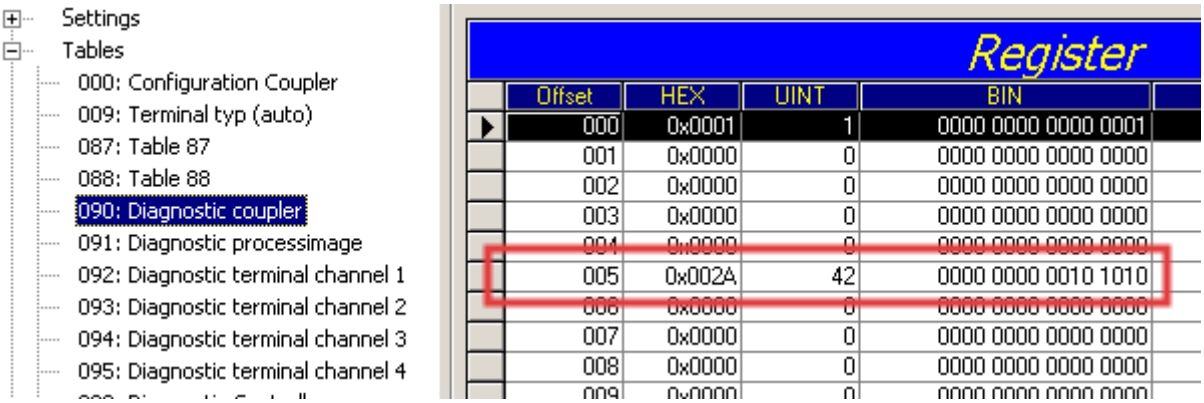
For this test, the fieldbus master (e.g. a PROFIBUS PC Card) should be on the bus and it should transmit data cyclical. Another way to generate cyclic data is, to switch the coupler to *free running* via the KS2000 software.

The result should be, that the I/O RUN LED flashes in a bright green. This shows, that a data exchange with the connected extension boxes takes place. A red blinking I/O ERR LED shows faulty IP-Link telegrams. These faulty telegrams will be repeated automatically like in any other fieldbus system. This way a transmission of the data is guaranteed.

Error counter

Table 90, offset 005 shows possible IP-Link errors. Sporadic appearing errors do not mean any problem for the communication, as long as they do not reach a critical limit.

This error counter is only reset by the Power ON/OFF.



If lots of errors occur in a very short time, this will be interpreted as a heavy disturbance of the communication and the coupler box will report this error. This can be seen at offset 006 and 007. Both values will show a value > 200 and the I/O ERR LEDs of the coupler box will blink the according error code.

Manual refresh needed

The KS2000 Configuration Software communicates with the Coupler Box via the serial channel. The content of the registers will not be refreshed automatically and has to be refreshed manually.

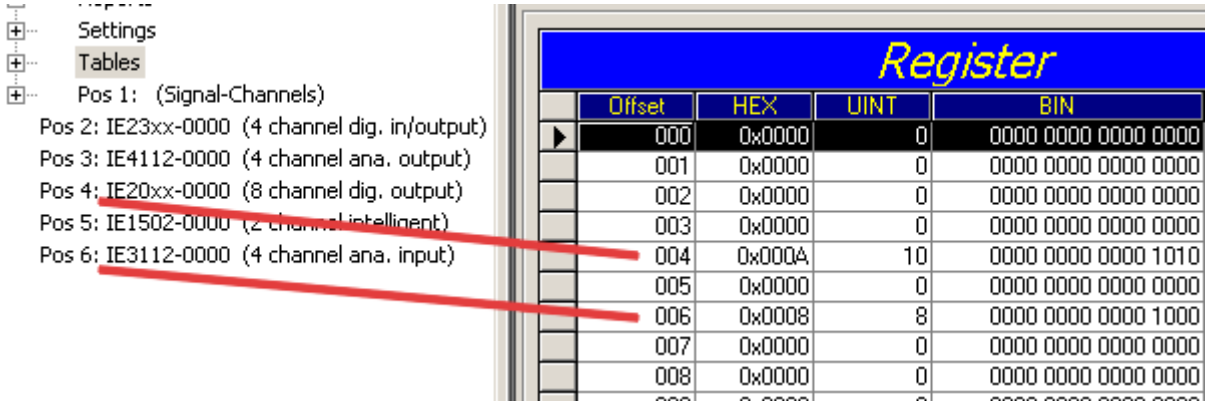
Position of the error

In case of an IP-Link error, the Coupler Box tries to read the error location from the register of the Extension Box. If the fiber optic ring is interrupted or the communication is heavily disturbed, this is not possible. Only the position of the last functioning Extension Box before the receiver of the Coupler Box can be recognized. The box will then flash this error code via the I/O ERR LED.

If the communication via IP-Link is still running, table 87 shows the error counter of each Extension Box.

The offset register corresponds to the position of the Extension Box in the KS2000 tree (left side of graphic). This example shows errors at offset 004 and 006.

In the "real" world the faulty IP-Link telegram was reported from the IE20xx and the IE3112, that means the problem has to looked for before these modules.



The error can be up to:

- the sending module
- the receiving module
- the IP-Link cable
- the connectors

If there is an error in table 90 and none in table 87, the faulty transmission is between the last Extension Box and the Coupler Box.

In most cases the transmission errors can be traced back to bad configured IP-Link connectors or a too high attenuation of the cable due to sharp bending.

The values of table 87 directly come from the extension boxes. In case of an IP-Link interruption these values will be set to zero and only table 90 can be used.

Operateon of a Coupler Box without Extension Modules

If you want to operate a Coupler Box (e.g. IL2300-Bxxx, IL2301-Bxxx or IL2302-Bxxx) totally without Extension Modules (IExxxx), you have to connect the send and receive socket of this Coupler Box directly by using an IP Link Cable! For this the IP Link Jumper ZK1020-0101-1000 fits perfect.

8 Accessories

8.1 Fieldbus Box accessories

The necessary accessories for the Fieldbus Box Modules are also available from Beckhoff in protection class IP67. You may get an overview from the Beckhoff catalog or from our internet pages (http://www.beckhoff.com).

Fieldbus Accessories

- Pre-assembled cable
- Plug
- Distributor

Power supply

- Pre-assembled cable
- Plug
- Distributor

Sensor power supply

- Pre-assembled cable
- Plug
- Distributor

IP-Link

- Pre-assembled cable
- Plug

8.2 Power cables

Ordering data

Order designation	Power lead	Screw-in connector	Contacts	Cross-section	Length
ZK2020-3200-0020	Straight socket, open end	M8	4-pin	0.34 mm^2	2.00 m
ZK2020-3200-0050					5.00 m
ZK2020-3200-0100					10.00 m
ZK2020-3400-0020	Angled socket, open end				2.00 m
ZK2020-3400-0050					5.00 m
ZK2020-3400-0100					10.00 m
ZK2020-3132-0001	Straight socket, straight socket				0.15 m
ZK2020-3132-0005					0.50 m
ZK2020-3132-0010					1.00 m
ZK2020-3132-0020					2.00 m
ZK2020-3132-0050					5.00 m
ZK2020-3334-0001	Angled socket, angled socket				0.15 m
ZK2020-3334-0005					0.50 m
ZK2020-3334-0010					1.00 m
ZK2020-3334-0020					2.00 m
ZK2020-3334-0050					5.00 m

Further available power cables may be found in the Beckhoff catalog or on our internet pages (http://www.beckhoff.com).

Technical data

Technical data	
Rated voltage according to IEC60 664-1	60 V_{AC} / 75 V_{DC}
Contamination level according to IEC 60 664-1	3/2
Insulation resistance IEC 60 512-2	>10^9W
Current carrying capacity according to IEC 60512-3	4 A
Volume resistance according to IEC 60512-2	< 5 mW
Protection class according to IEC 60529	IP65/66/67, when screwed together
Ambient temperature	-30°C to +80°C

9 Appendix

9.1 General operating conditions

Protection degrees (IP-Code)

The standard IEC 60529 (DIN EN 60529) defines the degrees of protection in different classes.

1. Number: dust protection and touch guard	Definition
0	Non-protected
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of Ø50 mm
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of Ø12,5 mm.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects Ø2,5 mm.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects Ø1 mm.
5	Protected against access to hazardous parts with a wire. Dust-protected. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire. Dust-tight. No intrusion of dust.

2. Number: water* protection	Definition
0	Non-protected
1	Protected against water drops
2	Protected against water drops when enclosure tilted up to 15°.
3	Protected against spraying water. Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water. Water splashed against the disclosure from any direction shall have no harmful effects
5	Protected against water jets
6	Protected against powerful water jets
7	Protected against the effects of temporary immersion in water. Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water for 30 min. in 1 m depth.

*) These protection classes define only protection against water!

Chemical Resistance

The Resistance relates to the Housing of the Fieldbus Box and the used metal parts.

Character	Resistance
Steam	at temperatures >100°C: not resistant
Sodium base liquor (ph-Value > 12)	at room temperature: resistant > 40°C: not resistant
Acetic acid	not resistant
Argon (technical clean)	resistant

Key

resistant: Lifetime several months
non inherently resistant: Lifetime several weeks
not resistant: Lifetime several hours resp. early decomposition

9.2 Approvals

Approvals

UL E172151

Conformity mark

CE

Type of protection

IP65/66/67 in accordance with EN60529

9.3 Test standards for device testing

EMC

Resistance: EN 61000-6-2

Emission: EN 61000-6-4

Resistance to Vibration

EN 60068-2-2 Vibration test, Amplitude 2 g (Standard 1 g)

EN 60068-2-27 Shock Test, Shock count 1000 (Standard 2)

9.4 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49 5246 963 157
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Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
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